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EDITORIALS

TELLING THE TRUTH TO THE HEALTH OFFICER.

Medical men will never come round to telling the truth about matters of public hygiene, or anything else which seems to conflict with the wishes of the patient, until they come to take a radically different view of their duties to the patient. At the present time it seems to me that the majority of men are governed by the respectable old individualistic idea that their whole duty in the practice of medicine is to the patient, and that his interests are always to be paramount. Those who fixed in our code of ethics this eighteenth-century individualism thought they were doing a very noble thing in making it clear that the doctor was not to serve his own interests, but rather those of the patient, when any conflict arose. It did not occur to them that there was a third party in the transaction,— namely, the general public and its interests.

But with a living interest in public and preventive medicine, which now at last I think has begun to increase by leaps and bounds, there comes upon the medical profession a dawning sense that they are the servants not of their patients primarily, but of the community first, last and all the time, and of their patients only in so far as their interests are identical with those of the community. It is for the patient's interest to keep it dark whenever we find an inconvenient case of infectious disease, but obviously enough it is for the public interest that we shall do nothing of the kind. Gradually physicians are beginning to be educated and to educate their patients up to the point of reporting the cases which are likely to leak out anyway, cases such as diphtheria, scarlet fever and small pox. When the matter can be decently hushed up, as in tuberculosis, it is still the practice of a great many physicians to be blind to their public duties and to serve private masters, namely their patients. Still more strongly is this the case when we come to those most dangerous and contagious of all common diseases, gonorrhea and syphilis; but with the listing of gonorrheal ophthalmia as reportable, the thin end of a huge wedge has been inserted, and I have hopes for the future in this direction.

I have no hope that any good will come to us from moral lectures or from editorials like the present. I look to great, unconscious forces, such as the public interest in hygiene and in preventive medicine, communicating themselves all unbeknown to doctors, and thus gradually changing their instinctively feudal habit of private spirit into one of public spirit. I cannot help thinking that it will come before long to seem ignoble and mean-spirited to serve a private master rather than to serve the public health, to be a henchman and a lackey,—as we are when we truckle to our patients' wishes in the face of what we know to be the public good.

But there are other great unconscious forces from which I hope for help in this fight. Medicine is certainly becom-

ing more scientific, and every step ahead in the progress of scientific medicine drives the lying habit nearer and nearer to distruction. When a man is in the habit of being hazy about his diagnoses and his treatments, the truth has no power in his mind, because it has no clearness. It is a whisper, not a shout. When, on the other hand, he has made his measurements and his examinations so deft and sharp that his diagnosis and treatment have clear outlines in his own mind, it will be much harder for him to make over the truth to suit his patient's or his pocket's interest. The scientific habit of mind, the scientific habit of taking our bearings direct from fact, and depending with a child's confidence upon our Mother Nature—is psychologically incompatible with the habit of fixing up the truth to suit somebody's wishes. The two cannot easily co-exist in the same mind.

It is the chief business then of those of us who care for truth in medicine not to preach and write upon the subject, but to work as hard as we can for public medicine and for scientific effort in all the fields of our profession. If we can make those two notes prevail, if we can make them dominant, truth-speaking will come of itself. A man could not, I think, realize the importance of public health, as health officers realize it from their close acquaintance with its powers for life and death, and yet go on plotting against the public weal as men do when they falsify statistics and conceal the truth in diagnosis. No doctor thinks it right to lie to shield a murderer, even if he is his patient, but the typhoid carrier, the gonorrhœic and the syphilitic, the diphtheria carrier, the tuberculosis carrier may be all of them murderers many times over, if only we can make them see it. To protect and shield them is treason to society. To bring home that truth to doctors, to patients and to the public is, I think, our chief duty and privilege.

RICHARD C. CABOT, M. D.

THE RELATION OF THE HEALTH OFFICER TO THE MEDICAL PROFESSION.

There can be no doubt that the successful enforcement of public health Regulations depends very largely upon the attitude of the medical profession toward such Regulations. If this attitude is one of cheerful and hearty compliance, the success of these Regulations is assured; if, however, the profession shows a grudging compliance or positive hostility, our Regulations must be more or less a failure.

For our present purposes we will consider only the protection of the public against contagious diseases. Here the rôle of the medical man is of the greatest importance, for he is the one who first sees disease.

Public Health Laws and Regulations generally impose certain duties on physicians, in these diseases, and hold them to a rather strict account for their performance.

Physicians are required to *report* such diseases to the local board of health, usually the health officer, also usually a fellow practitioner, and thereafter such cases become objects of care from both the attending physician and the health officer.

Furthermore the law (in Vermont, at least) requires that physicians report not only the cases which they *know* to be "contagious and dangerous to the public health," but also such as they *suspect* are such.

There are also the contact cases, those who have been exposed; there is the question of the length of quarantine and its stringency, and finally the details of cleaning up and disinfection, in all of which the health officer and the medical attendant have perhaps an equal interest.

In dealing with these contagious diseases, questions must

continually arise, in which the duty of the physician to his patient and that of the health officer to the public apparently conflict.

In the detail of diagnosis, there is often opportunity for very warm debate. The list of diseases which we construe as "contagious and dangerous to the public health" is yearly lengthening, and our facilities (Laboratory and otherwise) for accuracy in this detail are still limited; other features of the management of epidemic disease may furnish subjects for controversy between the health officer and medical man; and concessions are inevitable in arriving at a line of action. Who shall concede?

Our Public Health Laws and Regulations usually make the health officer the secretary and executive officer of the local board of health. The guardianship of the public health is directly in his hands. He has certain duties imposed by law, among the most important of which are those relating to the protection of the public against contagious diseases. He must know where these diseases are, whence they came, who are exposed, that his quarantine is respected, that the cases are kept isolated long enough, and that the infected premises are cleaned up after the case ends.

He comes into frequent and intimate contact with the medical profession in all these matters. The success or failure of preventive measures depends on the mutual action of both parties.

Each may annoy and hamper the other in what he conceives to be his duty.

Much depends upon the personality of the two men; upon their skill, their honesty and broadminded regard for the highest interests of the greatest number of people.

Medical men, like other human beings, are of various kinds; mostly honest, mostly skillful and mostly public spirited, yet sometimes otherwise. To an exceptional degree, medical men are sensitive in professional matters,

jealous of their ethical rights, tender of their patients' feelings.

Health officers are likewise human; though the ideal officer should combine qualities something more. These officers should be honest, intelligent, devoted to the public interests, fearless and tactful.

The combination of these rare qualifications in one man, it must be recognized, is extremely unusual.

A frank recognition of these facts should make all who are zealously striving for the protection of the public health seek to elevate this office; seek to make the selection of this officer a matter of first importance. And here it may be remarked that the local health officer should be a State Board appointment; thus ensuring the appointment for fitness, and removing it as far as possible from local influences.

In order that the health officer's relations to the medical men in his jurisdiction may inure to the highest public good, that officer should have the respect of the profession. He should have its respect always, its friendship as far as possible.

A very unpleasant duty devolves upon health officials at times to prosecute medical men, ofttimes brother practitioners. It is a duty, however, that may not be shirked when the occasion requires it for the protection of the public. That physicians are not prosecuted often enough to secure their full respect for public health regulations is probably true. It is a truism that lax enforcement of any law begets disrespect of that law.

To prosecute a doctor in court, and do this without leaving in its train bitterness and hostility, requires of the official peculiar qualifications. Personality must be buried; disinterested zeal for the highest public good must prominently appear.

Preventive medicine is daily taking more advanced grounds in all our laws and regulations. The medical pro-

fession is as steadily being held to more stringent public duties. On those whose duty it is to enforce our health laws a greater and more delicate task is being constantly imposed. It is imperative that the standards by which our health officers are selected should be made more exacting.

The dignity and pecuniary emoluments of these officers should be placed on higher planes—should be made more nearly commensurate with the peculiar and exacting duties which are expected of them. If we have noticed a lukewarmness among medical men toward our health laws, if there has occasionally been frank opposition to such laws and friction between the official and the doctor, it is proper that we inquire if the official has not been at least partially at fault.

Such complaints when sifted usually reveal only an overzealous, perhaps officious, health officer, or one lacking in good judgment and tact. Hence the prominence which a level head and tact, bordering at times on conciliatoriness, assume in the qualifications of the health officer.

To be sure our health laws do not, any more than others, take cognizance of individual peculiarities or preconceived opinions. Medical men have such peculiarities and opinions. They should waive these in the presence of public duty. This is an aspect of the situation that physicians are too apt to overlook. In their argument with the health officer, they forgot who may be the real sufferers. So when health officers and physicians cannot honestly agree, the concessions should be made in the interests of the public. The physician should bow to official judgment and action, reserving to himself the right to *think* as he pleases.

If official action under such circumstances is founded on intelligent investigation and evident impartiality, the relations between the health officer and physician need not be seriously strained.

The health officer, if he be a physician and one of two or three practicing in a small town, may easily make himself obnoxious to his brethren. It is conceivable that such an officer might visit contagious cases or suspected cases in the absence of the attending physician, or even remark on the diagnosis or treatment to outsiders. Such unprofessional conduct need not be seriously considered in this connection, except to remark that it is rare, and becoming, I believe, rarer daily.

The successful solution of any difficulty which there may be in the relation of health officers to medical men, I believe, will be found as I have indicated, in raising the standard of the former office. While the fault has probably not been wholly one-sided, the remedy should come largely from the side of the official.

And, finally, as in so many measures intended to benefit the public, we must look to the public for aid. Public opinion must warrant us in filling the health office with the best men available, by supporting such men morally and financially.

CHARLES S. CAVERLY,
President Vermont State Board of Health.

INDUCTIVE PUBLIC HYGIENE.

The conception of the study of public hygiene as the study not of fancies or fads but of determinable facts, from which tentative generalizations may be made, checked, revised, polished, reviewed, and finally established as principles for application in new instances, seems to be a product of the last few years. It is the application of such principles to new instances, the derivation from the new instances (always different in some manifestations from previous ones) of new side lights confirming or modifying the principles so far grasped that constitute at once the fascinations and the difficulties of public hygiene.

Such a conception of public hygiene differs wholly from the older, although still recent, conception which considered specific hygienic evils as mere examples of certain general laws, formulated by great hygienists of the past. This conception held that ill-health and especially the infections are due to and spread by certain vague factors, "peculiar weather," "ærial convection," "sewer gas," "excavation of the soil," even "general unsanitary conditions." To this conception was due the failure to examine closely the individual instance; to compare, contrast, speculate about and experiment with series of instances; to question the "established principles," or even to try critically whether or not "established principles" really applied in the specific instance at hand. The modern conception makes the study of a specific instance in public health practice as necessary as the detailed clinical study of a specific case in therapeutic practice. The health officer who would "diagnose" and "treat" an outbreak of an infectious disease without de-

tailed investigation is as irresponsible as the physician who would diagnose and treat a serious case on a telephone report. To tell a community in the throes of typhoid or diphtheria to "clean up" is worse than to dismiss a case of frank lobar pneumonia with nothing but advice "to take good care of himself."

A specific diagnosis leads to a specific treatment, adapted specifically to the case in hand. The (very young) medical student often thinks that therapeutic medicine merely means learning a list of diseases and then remembering which drug "goes with" each disease. So the health officer sometimes supposes that diphtheria means "close the schools," that malaria means "oil the water," that typhoid means "boil the water." Yet diphtheria is often better controlled by keeping the schools open; there is no object in oiling water, in which, for local reasons, mosquitoes will not breed; and typhoid may appear in a community with an unimpeachable water supply, with a water supply subject to temporary pollution, or with a water supply continuously and badly polluted—and the water *may have nothing to do with the typhoid at all, in any one of the three instances.*

To attribute every outbreak of typhoid to the water supply is no less silly than to attribute every abdominal pain to appendicitis. To require filtration wherever typhoid exists would be as inexcusable as to use tuberculin for every cold. If every muscular pain meant rheumatism and and all rheumatism yielded to salicylates, if every red rash meant scarlet fever and all scarlet fever yielded to sassafras tea, how sweet and pleasant would the path of the physician become! It is only the little knowledge, proverbially dangerous, which establishes such childish beliefs. As investigation into the problems of public hygiene goes on, there develops, as always in every other line of human investigation, more intricacies to solve, more evidence of the need for exacting technical and expert study of every individual

condition, first for correct diagnosis and then for logical, efficient and successful treatment.

These statements with the change of a few words here and there are but the statements made over and over again in the past for every science, and notably for therapeutic medicine, in the world-old struggle between accepted traditional teaching and new inductive experimental work. To illustrate their practical application to concrete problems, it is only necessary to look keenly at the existing status in almost any division of public health work.

At all times new beliefs, based on new and more exact data, have encountered opposition, not alone from those who, mentally lazy or mentally inert, prefer not to brace themselves to the shock of a new impression,—nor alone from those who feel that to accept a new teaching is an admission that their previous work and efforts have been in a wrong direction, but also from those who, only indirectly interested in the principles involved, have built upon the old teaching some important proceeding. Seldom is it that those personally interested in an "established" dictum welcome a discovery or a new teaching which "upsets the apple cart." This is but human nature. The plumber who was a revered oracle and savior of mankind when he alone (in current belief) could combat the insidious inroads of the fearful dragon "sewer gas," the disinfector who succeeded to the plumber's seat of frowning authority as the only one who could stay the transmission of dread infections, the engineer who upon the creed that typhoid fever comes from water, has built up a position of authority, half-accepted even by the public hygienists, so great that eyes are turning to him as the great sanitary force of the future—all these cannot cordially welcome the teachings that would rob them of their pre-eminent positions. Yet all such incidental agencies, depending on a single usefulness for their importance, must take their due and proper place in the scheme of things, and not attempt full control. The

plumber may still plumb, even though the future existence of the race no longer hinges on his efforts. Terminal disinfection has its place, although it is no longer regarded the chief weapon of the sanitarian. Typhoid comes from water sometimes—and sometimes water must be filtered. The engineer has scope and duties enough in improving the general conditions of life, without magnifying the one item of occasional reduction in typhoid fever into a clarion call for the supreme control of the life and health of the nation.

Ultimately to medicine, the science and art dealing intimately with the anatomy and physiology of the individual, on which all the relationships, personal, sociological and economic are necessarily based; but directly to public hygiene, the systematized outgrowth from medicine of the application of all forces to the preservation of society from physical disabilities, the protection of the public health on all sides naturally belongs. The sociologist may greatly aid here, the engineer there, the chemist in a third place, but to medicine alone, and because medicine alone comprehends in its grasp all sides of the question, belongs the application of the various available forces to the great end.

But to believe that therefore every medical man is *per se* and *ex-officio* competent to deal with public health problems would be great nonsense—as great as to believe that every "railroad man" is competent for any branch of railroading. Each railroad man differentiates into a definite field, becoming expert in that one—knowing, it is true, something about the others, but seldom knowing enough to be an authority outside of his own field. Neither a good switchman nor a first-class passenger agent is necessarily an expert train dispatcher. Unfortunately is has too often happened that the medical health officer has had to deal with problems involving for their proper solution technical aid, but has not realized the needs, or realizing them, was forced by circumstances to act himself. In the smaller communities practising physicians, without special hygienic

training or study, frequently find themselves forced to handle epidemics, problems of sewage disposal, of school architecture, etc., and have often and very naturally made messes of them—as much so as the obstetrician suddenly called to extract a cataract or a nose and throat specialist to diagnose and treat carcinoma of the breast. This is no reflection on medicine, on medical teaching or on medical men, but simply an illustration of the specialization of modern science.

A railroad engineer is not necessarily competent to construct a filter plant, nor is a county surveyor necessarily a good waterworks superintendent—as certain communities have found to their cost. That engineering as a science contains in some of its subdivisions, understood and practised, according to their capacities and bents, by some engineers, the solution of several hygienic problems, is no guarantee that the first engineer encountered will prove to be an authority on every phase of sanitary engineering—much less on sanitation in general. That medicine as a science contains in some of its subdivisions, understood and practised, according to their capacities and bents by some physicians, the solution of several hygienic problems, is no guarantee that the first physician encountered will prove to be an authority on every phase of sanitary medicine—much less on sanitation in general. But at best, the engineer cannot as a rule deal directly with more than the transmission of one disease, typhoid—and then chiefly with the water-borne variety; while the physician at worst is more or less familiar with all the infections. The change from the individualistic viewpoint of the physician to the sociological viewpoint of the public hygienist involves no such complete dislocation as would the change necessary to an engineer in turning from the consideration of stones and mortar to the control of the bodies and the lives of his fellow man.

Yet this is all somewhat beside the point. That public hygiene is a study yet incomplete excuses those attempting,

even though they needs must fail, to master its entirety. But no one man will ever grasp it all. If we see this and, leaving prejudice, pursue the truth, each in his proper field, there will arise, in time, a science; and he who best applies it must then be leader. To medicine, it seems, belongs the larger field. Then all the more should medicine explore it, and yet with humble mind acknowledge each aid and good example from without.

H. W. HILL.

SPECIAL ARTICLE

THE PRINCIPLES OF SMOKELESS COMBUSTION.

By EDWIN S. HALLETT
St. Louis, Mo.

For many years there has been an agitation of the smoke question in the large cities, and without inquiry or study of the combustion problems, the cities near the anthracite beds considered the problem solved by requiring coal users to burn hard coal or coke. The high price of this class of fuel soon became prohibitive for commercial purposes, especially for such industries as come in competition with the cheap bituminous coals. A quantity of bituminous coal of Illinois can be delivered to any city in the state which will have a heating value equal to a ton of anthracite for less than three dollars. It appears, then, that smoke is levying a duty of more than a hundred per cent. upon the industries and that such as are in competitive trade can not pay it.

It is an astounding fact that the damage done to health, to manufactured fabrics, in store and in use, to buildings, to foliage and flowers and to the personal comfort of the millions, should continue unabated with a remedy at hand and that without expense to the coal user or the municipality. In fact from purely a fuel standpoint there is a profit in the better combustion that is necessary to prevent smoke. This slow progress of the smoke prevention appears to be due to a popular impression that smoke is necessary to prosperity. You frequently hear the jocular reply that what we want is more smoke these hard times. A smoking chimney should mark the firm as not informed, at least upon one branch of his own business. The most needed asset in the engineering profession today is a proclamation, heralded far and

wide, shouted in the ear of every coal user in the land, that coal of the poorest quality can be burned without an objectionable amount of smoke, and with greater economy aside from the price of the coal, and without the necessity of installing expensive apparatus to do it.

To say that coal high in volatile matter cannot be burned economically without smoke is as absurd and as wide of the truth as to say that the medical profession had made no advancement in the cure of diphtheria. It is not a lack of engineering information but a failure in the popular dissemination of it.

It is the purpose of this brief review to set forth a few fundamental facts, divested of technical terms, which if acted upon would rid us of the greater part of the smoke nuisance. All coal contains essentially these parts in varying proportions, namely: carbon, or as we say fixed carbon; volatile hydro-carbon, the portion which is driven off as a gas when heated but before combustion; sulphur in various compounds; ash, the non-combustible mineral matter; and moisture. The difference between anthracite coal and bituminous coal is the relative proportions of fixed carbon and volatile matter. With hard coal the large proportion of fixed carbon produces so much heat that the small distillation of volatile matter is burned as it is driven off. Bituminous coals vary in amount of volatile matter from say 20% to 50%. That is, coal is mined with all amounts of volatile matter but we name those having less than about 18% or 20% as anthracite and all above that as bituminous. The distillation of this gaseous portion begins at a low temperature and is quite perceptible at five or six hundred degrees Fahr. and increases rapidly up to the point of complete combustion, which is between 1300 and 2000 degrees. With a very light fire nearly all the volatile matter may be distilled out and pass up the stack and be lost. Not all the gas passing off is visible as smoke but the smoke is a reliable indicator of the extent of the loss. It follows then

that the first step in smokeless combustion is to pass this distillate through a chamber that is hot enough for combustion and which is supplied with a sufficient quantity of air, which also should be warm. The very remarkable condition that exists at present in the average steam plant is that in which the gases are distilled on the surface of the fire and pass up, striking the cold boiler surface, which chills them beyond any possibility of ever being burned. This chilled carbon gas is non-combustible even in a high temperature. For this reason we never use the expression "burning smoke," for once the smoke is formed as indicated above it is past all chance of ever being anything but smoke or soot. The common fire-tube boiler with the straight grate, hand-fired, is about the worst construction that could be thought of for burning soft coal. The temperature of the water in a boiler under 100 pounds of steam pressure is 337 degrees. The shell of the boiler cannot be made much warmer than that with this steam pressure. This is about a thousand degrees too low for combustion to take place. What happens, then, when coal is shovelled into a furnace of this kind? The hydro-carbon gas as it is distilled strikes the relatively cold boiler shell and forms a flake of soot, which is as incombustible as graphite which it resembles. If the combustion does not take place before this chilling it never can afterward. Just here is the secret of the whole business. The fatal blunder is in attempting to heat a boiler with distilled but unburned gases. So long as the process of combustion is taking place the gases should not be permitted to come in contact with the boiler plate or tube surface. They should be carried under fire-brick arches and if possible thrust against a brick wall, and supplied at this point with additional fresh air so admitted as to be well mixed with the igniting gases. Now with this statement of facts it will not be difficult for any one to construct a furnace that will meet these conditions. There is no patent on this. There are obviously many

plans which are inexpensive and require no skilled labor but a good bricklayer. New settings will permit a more perfect job, but any furnace can be perfectly equipped without disturbing the boiler or shutting down longer than is required to clean out.

In classifying the various means of effecting perfect coal combustion the following would be good: (1) Special brick arches for hand-fired furnaces. (2) The down-draft, a patent hand-fired furnace. (3) The mechanical stokers. (4) The steam jet devices, also patented. The fundamental in all perfect furnaces is the fire-brick arch. The best setting for the common shell firetube boiler is that with a brick arch extending the full length of the boiler, the crown of the arch just beneath the belly of the boiler. Apparently this would decrease the capacity of the boiler, but experience indicates the contrary. The arch may stop just back of the grates, and a wall supported on an arch run across the furnace cavity and extending up around the girth of the boiler and down to the bridge-wall, but say 18 inches back of it, in such a manner as to act as a baffle, which becomes incandescent with heat and at the point of deflection of the flame mixes and burns all the gases. At the bridge-wall a supply of air should be admitted through small apertures to make the combustion perfect. (See fig. 1.) The arch is often built forward from the boiler and is called the Dutch Oven. The obstructing fire-brick work for mixing and heating the gases at the rear of grates may take many different forms but the cross section must not be reduced so far as to impair the draft. It must be remembered that no brickwork will long withstand the great heat.

The down-draft furnace is one of the most perfectly smokeless forms yet devised. It consists of two sets of grates, the lower of the ordinary cast iron bar, the upper is made of 2″ or 2½″ tubes entered into small drums front and back, the whole having a circulation of water from the boiler. The tube grates rise backward to give circulation to

the water to prevent burning out. The heating surface of the grate is said to add 25% to the capacity of the boiler. In operating, the coal is all fired upon the water tube grates, and a portion of the coal falls upon the common grates, and the flames from the two fires meet in the chamber where the heat becomes very intense. The distilled hydro-carbons gases of the fresh coal must pass through the lower hot fire as well as through this combustion chamber before they reach any cooling surface. This furnace will burn any kind of bituminous coal, but lump coal must be used in starting fires if it be of the non-caking variety. The first cost of the furnace is large and the cost of maintaining the water grates is necessarily high. However the economy in having perfect combustion would cover that objection.

The mechanical stokers have their special field of usefulness. They came as a means of burning the otherwise useless fine coal which was carted to the dump from the mines. Many of the stokers are built on correct lines and when properly handled give good efficiency. The coal is automatically fed into the furnace from the front edge or from the front and sides, or in some instances pushed in from the bottom and spread out in such a manner that the distillation takes place at the outer margin, and thus must pass over the high temperature of the rear furnace. This layer of coal may be made thick or thin as the draft will permit. The stoker is decidely the furnace of the large unit. The coal is handled by conveyors into bunkers overhead and is fed by gravity to the stokers with no hand labor.

The last group of smoke consumers which I will mention is the steam jet device. This is an attachment for hand-fired furnaces by which a steam jet is turned in over the fire with a blast of air at the time a fresh charge of coal is applied. The principle upon which it works is that the gases burn at a lower temperature when mixed with an excess of air with steam. The effect of the blast of steam and air is to deflect the flame from the boiler sheet. After the first

distillation is over, in about a minute, the steam and air are automatically cut off. Such a device is very satisfactory as an emergency, but it costs something for steam and lowers the furnace temperature rather than raising it.

From the engineer's standpoint the smoke problem has been solved in a way that meets every demand. The objector has had the last prop knocked from under him. There is not a valid argument to resist the compulsory ordinances of the cities that want to be clean. There is not even an occasion for delay in enforcing ordinances, as the cost of temporary equipment is so small, not to mention the returns due to high furnace efficiency. The most needed step is a widespread knowledge of the facts set forth in the foregoing statement.

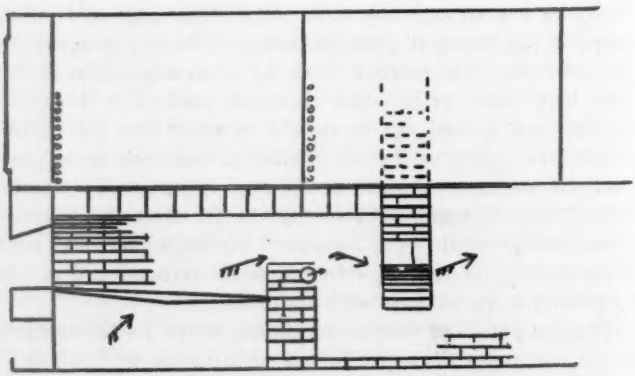

FIG. 1

AMERICAN PUBLIC HEALTH ASSOCIATION

POLLUTION OF THE GREAT LAKES.*

By Dr. JOHN A. AMYOT
Toronto

The Great Lake water system consists of Lakes Superior, Michigan, Huron, Erie and Ontario, with their connecting rivers or straits.

They include an area of 98,640 square miles.

The approximate dimensions of them are as follows:

Lake Superior	350 miles	x	150 miles
Lake Michigan	300 "	x	80 "
Lake Huron	300 "	x	120 "
Lake Erie	225 "	x	70 "
Lake Ontario	200 "	x	50 "

The depth of these lakes has the following averages:

Lake Superior	900 feet
Lake Michigan	800 "
Lake Huron	900 "
Lake Erie	120 "
Lake Ontario	500 "

Their elevations above the sea are as follows:

Lake Superior	600 feet
Lake Michigan	576 "
Lake Huron	574 "
Lake Erie	565 "
Lake Ontario	247 "

The supply of water is inexhaustible for all the population that could be crowded around these inland seas. Over four million people now use this source.

The following table will show the approximate chemical

*Read before the American Public Health Association at Winnipeg, August, 1908.

composition of these waters taken at several points during this last summer:

POLLUTION OF THE GREAT LAKES

IN PARTS PER MILLION

Point from which Collected	Free Amm.	Alb. Ammonia	Nitrates	Nitrites	Ox. Cons.	Chlorine	Hardness			Turbidity	Color
							Total	Perm.	Temp.		
Port Arthur	0	.055	.395	trace	2.88	1	84.5	68.5	18.0	30	0
Soo. Ste Marie	0	.029			1.77	1	46.1	46.1	0	1.5	0
Kincardine	. 01	. 06	. 16	trace		3	116	92	24	2	0
Goderich	0	.045	. 09	.0005	1.00	3	111	100	11	45	0
Sarnia	.010	.045	.092	.0028	1.15	3	120	93	27	3	0
Courtright	0	.048	.0938	.0015	.74	4	116	94	22	3	0
Windsor	0	. 07	. 18			8	126	102	24	45	0
Bridgeburg	.008	.050			1.61	8	128	112	16	1.5	0
Toronto	.012	.048	.153	0045	1.45	8	148	98	50	4	0
Brockville	.013	.057	.087	trace	1.05	8	147.0	95	52	2.5	0

The nitrogen content is low in all of them, averaging about .1425 all told, at Courtright, a fairly representative point.

In oxygen consuming material rarely more than 1.25 per million is found.

The total organic content, therefore, of these waters is extremely low, and is generally constant within 10%.

The chlorine content, beginning at Lake Superior with 1 per million, reaches 3 in Lake Huron, at Godwich, and at Port Huron, 4 at the lower end of the St. Clair river at Courtright, where, as at Bridgeburgh, opposite Buffalo, at the entrance into the Niagara river, it reaches 8 per million. In Lake Ontario this holds pretty constantly, and in the St. Lawrence river, at Brockville, it is still unaugmented. It remains 8 per million. Salt reaches abound on both lower shores of Lake Huron and along the River St. Clair, Lake St. Clair, and the Detroit river. There is now around this point and in the immediate vicinity, or on the shores of Lake Erie, the largest population collected along the Great Lakes, and most of these people use salt from the

Huron-St. Clair region. The great bulk, on account of the great depth and the amount of dilution water entering, probably keeps the Lake Ontario chlorine unincreased over Lake Erie. The *hardness* of the waters of the Great Lakes is largely carbonate of lime in origin. It begins at Lake Superior with about 50 parts per million and ends in the St. Lawrence river with 148 or 150 parts per million. This is just enough to make it pleasant drinking, to not encrust boilers too severely, and to allow us to use lead pipe without danger in our plumbing. This hardness at any given point is generally quite constant. The *turbidity* is generally not more than 2 per million, and after great storms rarely goes above 40 per million. Exception must be made in the case of Lake Erie, the shallowest and the most storm-disturbed of all the Great Lakes. In this lake it is the exception to find its water showing below 20-25 parts per million of turbidity. Some of the river cities would not think this an undesirable water.

This lack of turbidity has its disadvantage for the hygienist, for when he tries to convince the people that the water is sometimes dangerous they look at him with incredulity, holding a glass of this clear water up before him. A cubic centimeter of—a vigorous culture of—typhoid bacilli in a pailful of water wouldn't make it look less clear to an ordinary observer than it was before. In the open of these lakes (miles out) the bacterial count rarely exceeds 10 per cubic centimeter, and does not contain colon bacilli, though the sewage of over four million people is discharged practically untreated into it. The final dilution is great, the sedimentation is great, and down where nature gets plenty of time to finally decompose it all.

If we could get our water intakes out 10 or 12 miles from the shore, in most cases we would get this almost bacteria free and almost certainly sewage free water. But the shore bottoms of all these lakes, except Lake Erie, drop

almost precipitously so that at the distance of a mile from shore the water is quite frequently 200 feet in depth. In the neighborhood of our cities it has frequently been observed that with favoring winds, streams of uncharged sewage, like the Gulf stream, wend their way out from shore as much as three or four miles. The winds are very inconstant in direction in these lakes, so that these streams may easily be blown up or down shore. Winds up or down the lake lasting any length of time cause piling up of the water. When this finds its level currents of inconstant direction start up or down the lake.

The normal temperature of these waters in the summer months is rarely above 40° F., except on the surface. The surface water may go up in temperature to 60° F., especially in the Lower Lakes. This surface water blown in on the shore recedes by an undercurrent, often reaching a depth of even 50 feet, as far as a mile from shore. In this way, if the surface water is found infected the deep water going into an intake may become infected. Again, over an intake that millions of gallons of water are entering, surface water converges, even though the mouth of the pipe is as deep down as it can be placed in practicable practise. In the case of streams entering the lakes they do not run out into the lake in a constant direction. The chlorine estimation will show that sometimes it is up, sometimes down the lake, corresponding to the direction of the winds or governed by the currents in the lake produced by those combined winds spoken of above.

No population emptying its sewage into one of these lakes can with safety take its water supply from it even miles away from the outfall without paying for it in deaths from typhoid and other intestinal diseases. The farther out from shore and the deeper the mouth of the intake is from the sewage entrance the less frequent are the chances of infection, but they will come. We sometimes hear engi-

neers say the prevailing winds are in a certain direction, therefore the intake should be placed in the opposite direction, and all will be well. But we should guard against the occasional, as well as the prevailing. If we kept the sewage out of these waters they would be ideal, but this is nearly an impossibility. Sewage disposal methods are notoriously uncertain.

They will not remove all pathogenic organisms, often not even organic matters (the best of them), at all times and under all conditions. Some of them are expected to remove organic matter and pathogenic bacteria. Some of them remove organic matter and only a small percentage of the bacteria. The sterilizing methods are designed to remove the bacteria. All of them are more or less crude and usually badly managed; the result is lack of uniformity in action and occasional infections with the resultant dangers. They are all of them much better than nothing, and many of them reach nearly the ideal, but we can't safely place our trust in a plant that almost of necessity takes a holiday, sometimes drinks too much and from overfeeding gets indigestion. The occasional failures are serious to the users of the water.

Some cities on the Great Lakes have diverted their sewage to their neighbors, a decidedly unkind procedure (Chicago, for instance), but when all this is done the shipping still remains, and into the harbors of some of these cities this is considerable.

Their sewage almost invariably passes into the water without treatment. Zurich treated its sewage, had a clear, beautiful water to draw its supply from, but its typhoid rate was 75 per 100,000. The shipping did it. Hamburg got its cholera epidemic from the shipping. Some of the cities and small towns on the Great Lakes have had typhoid passed to them in this way.

The following striking examples of the experience of

some of the Great Lake cities are opportune at this point:

When Chicago drew its water supply from intakes a mile from shore its typhoid rate for the last three years of this condition was 82 per 100,000. Placing their intakes four miles out, leaving the sewer outlets where they were, reduced the rate to 40 per 100,000. Diverting three-quarters of their sewage later on, leaving the four-mile intakes unaltered, reduced the rate to 22 per 100,000. The sewage of one-quarter of a million people still reaches the lake.

In Cleveland, with an intake not far from the exit of the harbor (the greater part of Cleveland's sewage was discharged into this), there was a rate of 165 per 100,000 for the last two years of the condition. A new intake four miles out and in another direction, the typhoid rate for the next two years fell to 22 per 100,000.

In Toronto, with a faulty conduit under a sewage-polluted bay, for five years the typhoid rate was 55 per 100,000. A replacing steel pipe reduced the rate during the next five years to 20 per 100,000.

The bacteriological analysis of the waters of several of these cities shows a considerable percentage of the samples to contain colon bacilli, and in many of these cases we can't console ourselves by the statement that these may have come from animals other than man, for there is very little drainage from pasture lands in the neighborhood of these cities going into these supplies, such as happens with supplies like that of New York and Boston. They are in a preponderating proportion from the human intestine.

Very few of these cities show typhoid rates below 20 per 100,000, notwithstanding the fact that they are all well sewered, use very little well water, have very fair milk supplies, and are not swarmed with flies.

Yet no cities in temperate zones with unquestioned water supplies show such high typhoid rates. Vienna and Munich, with mountain-top supplies; Frankfort and Dres-

den, with artesian supplies in unquestioned soils; Zurich, Hamburg, Rotterdam and London, with properly-filtered water, show rates rarely exceeding 7 or 8 per 100,000. They all had high rates before. Now, physically and chemically, these Great Lakes supply waters that cannot be surpassed in the world. From the hygienic standpoint they all show that they are dangerous from our own very neglect and lack of appreciation of what we are asking them to do. We throw our sewage into them and expect them to give us pure water. We won't give them time to purify it, nor have we so far given them any help.

The remedy obviously is to reduce that pollution by the introduction of appropriate methods of sewage disposal, and last but most important of all, filtration by the slow sand filtration method that will guard us all the days of the year and all the minutes of the days in about as certain a manner as the ingenuity of man has yet been able to devise.

Toronto, in June of this year, voted $3,700,000 for the disposal of its sewage and the filtration of its Lake Ontario water supply, and is hoping for a great big reduction in its typhoid and intestinal disease morbidity and mortality.

DISCUSSION.

MR. GILBERT H. PRATT, of Providence, R. I.—If I remember rightly, Dr. Amyot made the statement that the water of the Great Lakes is not adapted to treatment by mechanical filtration. I would ask whether any actual experimental work has been done in this regard, and also, whether there has been any study of the rates under slow sand filtration?

DR. AMYOT—From a hygienic standpoint, there is no doubt that lake water can be filtered by that method.

MR. HARRY E. JORDAN, of Indianapolis, Ind.—In the city of Indianapolis, during the course of the last year, over six thousand analyses of water of the city gave a bacterial content of 26 per c. c.; colon reaction positive, 3.2 per cent. of the samples; at the same time, the regular monthly analyses of various bottled waters gave a bacterial content of 125, with 7 1-2 per cent. of positive colon reactions.

In the city of Independence, Mo., a somewhat similar condition occurred. The people were not satisfied with the condition of the public water supply, which was drawn from the Missouri river and purified by passing through a series of settling basins. They were in the habit of buying spring waters whose source was the fissured limestone over which the town was built. This was originally quite pure, but the settlement of the city of Independence has polluted the limestone strata, and examinations of this supply during this year showed a bacterial content of 1,500 to 3,000 per c. c., with the colon bacillus practically constant, while the city supply showed a bacterial content of only one-third to one-half as much with the colon bacillus present 20 per cent. of the time. These waters are often sold in bottles that are improperly cared for, no attempt being made to sterilize them before refilling. Their handling by typhoid patients and their nurses is a source of danger of the same sort as occurs in the infection of milk bottles.

DR. JAMES D. LAFFERTY, of Calgary, Alberta—According to the Public Health Act, our Provincial Board has absolute power and control over domestic water supply in the Province. No municipality, corporation or person can begin or take the first steps towards a public water supply for domestic use or make any change in the same if in use, until they have submitted to the Provincial

Board, plans and specifications, and an analysis of the water, and receive the approval of the board.

The Government has appointed a sanitary engineer as a member of the board, on whom devolves the responsibility of approving plans, and examining water and systems which are submitted to us. Further than that we have absolute supervision of all streams and waters to provide against pollution of these waters; moreover, our decision is absolute. There is no appeal from the decision of the Provincial Board of Health in Alberta in matters of this kind, and I think it is well that it should be so.

STATE CONTROL OF PUBLIC WATER SUPPLIES*

By CHARLES O. PROBST, M.D.
Columbus, Ohio

A few years ago the writer was visiting a friend some twenty-five miles from home, and in driving about the country stopped for dinner at a little hotel kept by a widow. The picture of a fine young man of about twenty-four attracted my attention. I asked the proprietress who it was. With tears stealing down her cheeks, she informed me that it was the picture of her only son who had died a few weeks before from typhoid fever contracted in Columbus.

There is a small pleasure resort on an island in Lake Erie in the State of Ohio, where many thousands of visitors go for a day, or a few hours between boats, during the summer. The sewage from many hotels and eating houses pours into a land-locked bay, where are also the boat landings. Water is pumped from this bay and is served at many places for drinking purposes.

How many cases of sickness never traced to this source are caused by these conditions, none can tell. The villagers have been indifferent and unwilling to bear the expense of introducing sewerage and pure water.

Should the correction of such conditions, which I presume exist in most of the States and Provinces, be left entirely to the local authorities? Most emphatically not, in my opinion.

If a polluted public water supply concerned only the

*Read before the American Public Health Association at Winnipeg, August, 1908.

community that uses it, there might be some argument in favor of home rule, though in this case it would more properly be home mis-rule.

But this is not a local question. In these days of rapid transit and involved business and social relations, conditions differ greatly from what they were in the walled cities of former generations. The State has become in large measure one community, and it must assume increasing responsibility for the conditions which threaten the lives and health of the people.

If the State has the *power* to prevent a municipality from furnishing impure water we cannot escape the conclusion that it should use this power when that becomes necessary.

When, and to what extent, should the State assume control of public water supplies?

In the first place, it should be the duty of the State to protect from pollution, as far as possible, all sources of water supplies of which use is being made.

Municipalities might be given power to protect themselves, but this is a grant of power that municipalities are very slow to make use of. For instance, in Ohio, municipalities have authority under the law to prevent and punish pollution of a public water supply within a distance of twenty miles, but no use has been made of this power.

And why twenty miles? How far may dangerous pollution of streams extend? The old English Commission said there was no stream in England long enough to recover itself. True, the streams in England are not very long.

Was St. Louis hurt by Chicago? Many think so, and the United States Government was appealed to for protection.

Suppose Chicago should admit it, but say to St. Louis: "Remove the little pollution we contribute to your water supply by proper methods of purification."

The question coming up in all populous States is: Can

the streams and watersheds that must furnish public water supplies be kept free from contamination by laws and inspection?

This may be possible for some of the States, but not for the great Middle-West territory, where usually municipal and industrial wastes must go to the streams.

Should these wastes be purified in all cases where the stream is used in any part of its course as a public water supply, or should water purification be depended upon for protection?

We cannot settle this problem for all communities in general terms. Each community affords a problem of its own. We may have to cleanse the sewage of the town above and purify the water of the one below in order to protect the latter. In other cases it is possible that either procedure would accomplish this.

In that case who shall decide whether the town above shall purify its sewage, or the users of the water below be made to filter it.

The State, as I see it, can best settle such questions. It may do this by giving adequate authority to some commission to control all sources of public water supply, and to prohibit the use of its waters for the disposal of municipal or industrial wastes without the permission of such commission. Instead of creating a special commission for such work, it is much better, in my judgment, to give this authority to the State or Provincial Board of Health.

I can best express my views of what should be the relation of the State to municipal water supplies by giving the salient features of recent legislation in Ohio, and this is my excuse for referring to home affairs.

The Act under which the State Board of Health has operated since 1893, in the approval of plans for water or sewage works, was materially strengthened by adding a penalty of from one to five hundred dollars for its violation.

In addition, no garbage or manufacturing plant having a liquid waste which may enter any stream within twenty miles above the intake of any public water supply, may be established, until the location of such plant, including plans for disposal of the wastes, have been approved by the State Board of Health.

A new Act gives the State Board of Health much larger powers for the protection of the waters of the State, and of existing public water supplies. The Act provides that when official complaint is made to the board that any municipal or other corporation, or person, is discharging sewage or other waste into any stream or body of water, and is thereby creating a nuisance detrimental to health or comfort, or is polluting any public water supply, the board, after investigation, and after a public hearing, may require the introduction or enlargement, if existing, of sewage purification works, or such other installations or changes as it may deem necessary to remove the cause of complaint. The board's order to that effect must be carried out within a time to be fixed by the board.

It is further provided that when official complaint is made to the board that the public water supply of any city or village is polluted and dangerous to health, the board shall investigate the charges. If substantiated, and if it is found that the sources of pollution cannot well be removed, the board, after a hearing, may order the corporation or person owning or operating the water works, to change the source of supply, or to introduce purification works, or to change or enlarge existing purification works, if that will give adequate protection.

In both cases the order of the board and the time within which it shall be executed must be approved by the Governor and the Attorney-General.

It will be noted that in both cases the initiative must be taken by some local authority. In the case of pollution of

a stream or lake the complaint must be made by the council or board of health of some city or village, or the commissioners of any county, or trustees of any township. In the case of pollution of a public water supply the complaint is to be made by the board of health or health officer of any city or village, or 10 per cent. of the electors thereof.

Supplementary to these two sections is another giving the board control of all water and sewage purification plants.

The board has recently made a special and extended investigation of all such plants in the State. It was found that many of these, through faults of construction or operation, or both, were giving poor results. An inefficient municipal filter is for the public, what the usual household filter is for the family—highly dangerous if the water supply is polluted.

To meet this condition the new Act provides that whenever the board finds that any water or sewage purification works, on account of incompetent supervision or operation, is inefficient, the board, with the approval of the Governor and Attorney-General, may order the owners, or those in charge of such plant, to make such changes in operation within five days as will secure an effluent satisfactory to the board. If they fail in doing this, then the board may require them, within ten days, to appoint, with the approval of the board, a competent person, and pay his salary, who shall take charge of the plant and operate it until results satisfactory to the board are obtained.

It has been found in our State that the limit of permissible bonded indebtedness of municipalities has been the most serious obstacle in securing water and sewage purification plants. Especially is this true as regards sewage disposal plants, as such plants are not usually for the direct benefit of those who have to pay for them. A large number of our cities and villages have about reached their bond

limit in payment of other municipal improvements, and when asked to introduce needed water or sewage purification works, have been able to reply that it was legally impossible under the bond limit.

To meet this it is provided that municipalities, for carrying out the provisions of the Act, may exceed their bond limit already provided by 5 per cent. of the total value of all property listed for taxation.

It is made the duty of all municipal officers who have to do with the raising of tax levies, to provide, within the limit named, for such sums as may be necessary to carry out the orders of the State Board of Health for the purposes mentioned.

The arbitration clause of the Act should be referred to. When the bill, which did not include this clause, was introduced, it raised a storm of opposition from municipal officers, which seemed likely to defeat it. This was almost wholly removed by providing for arbitration.

If the orders of the State Board of Health, after approval by the Governor and Attorney-General, are not satisfactory, they are to be submitted to two experienced sanitary engineers, one chosen by the board and one by the corporation or person affected. If they do not agree, they choose a third. They may affirm, modify or reject any order, and their findings must be accepted by the board and be enforced in the same manner as an original order.

The expense of arbitration is divided equally between the State and those requesting such reference.

A penalty of $500 is provided for the failure or refusal of any person to perform any duty required of him by the Act. This would include the mayor, members of council, city solicitor, and all boards or officials in charge of or responsible for either water or sewage works.

The Act may be enforced by the Attorney-General bringing suit at the State Capital, thus avoiding a local

jury. The Governor and Attorney-General may, however, remit all or a part of the penalty upon good and sufficient cause being shown.

It remains to be seen what results will follow the proper enforcement of this Act. One further step should be taken to give the State full control. No municipality, corporation or person should be permitted to place anything of an injurious character into any stream or body of water that is being made use of for a public water supply, without the approval of the State Board of Health, and that board should have a sufficient number of inspectors to keep all sources of supply under close supervision.

WATER PROBLEMS OF ILLINOIS AND NEIGHBORING STATES.[1]

By EDWARD BARTOW

Since the term "Middle West" is rather vague the writer has decided to consider only his own State and neighboring States, namely: Michigan, Indiana, Kentucky, Missouri, Iowa, Wisconsin and Minnesota. Probably the most extensive work on water problems of these States has been done by Frank Leverett*, who has made a study of the well waters of the Illinois glacial lobe and of flowing wells and water supplies from other sources in Michigan.

Dr. A. C. Lane† had previously discussed the mineral waters of Michigan. W. S. Blatchley‡, State Geologist of Indiana, has made a report of the mineral waters of Indiana. W. G. Kirchoffer§ treats of the sources of water supplies in Wisconsin. L. S. Smith|| has discussed the water powers of northern Wisconsin. W. H. Norton[a] with Samuel Calvin and A. G. Leonard, has made a report on the artesian wells of Iowa. Edward M. Shepherd[b] has made a study of the

[1]Read before the American Public Health Association at Winnipeg, August, 1908.

*Monograph No. 38, United States Geological Survey, 1899.

*Flowing Wells and Municipal Water Supplies of Michigan, 1906 and 7.

†Water Supply and Irrigation Paper No. 31 of the United States Geological Survey, 1899.

‡Twenty-sixth and Twenty-seventh Annual Reports of the Department of Geology, Indiana, 1901-2.

§Bulletin of the University of Wisconsin, No. 106, 1905.

||United States Geological Survey, Water Supply and Irrigation Paper No. 156, 1906.

aIowa Geological Survey, Vol. VI, 1907.

bUnderground Waters of Missouri, United States Geological Survey, Water Supply and Irrigation Paper No. 195, 1907.

underground waters of Missouri. Reports by A. W. Palmer[c] and Edward Bartow[d] have described conditions existing in Illinois. R. B. Dole[e] and F. F. Wesbrook report on surface waters in Minnesota. Reports of a general nature have been made by H. K. Barrows and A. H. Horton[f] on the surface water supply of Great Lake and St. Lawrence river drainages; and D. W. Mead[g] on The Hydrology of the Upper Mississippi Valley, and the Geology of Wisconsin Water Supplies.

It seems inadvisable in this paper to deal with other than water problems of interest to the sanitarian or to those interested in furnishing water to municipalities.

Of the States mentioned, Michigan, Indiana, Illinois, Wisconsin and Minnesota have a common interest in water from the Great Lakes. Michigan only has no interest in the Mississippi river and its tributaries. Artesian water is found in all of the States. In Minnesota, Wisconsin, and Michigan are found numerous small lakes from which water supplies may be taken. All of the States have a common interest in the shallow well, which furnishes a supply of water to a large proportion of the inhabitants dwelling in the smaller municipalities and on the farms. Illinois, situated in the centre of this group of States, has all the conditions mentioned, except the possibility of obtaining a water supply from small lakes. Therefore, a consideration of the water problems of Illinois, relating to Lake Michigan, to the Mississippi and its tributaries, and to the deep and shallow well waters, may be considered as, to a certain extent, a considera-

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cChemical Survey of the Water Supplies of Illinois, Preliminary Report, 1897.

cReport for years 1897-1902.

dReport for year ending August 31, 1906, and Municipal Water Supplies of Illinois, 1908.

eWater Supply and Irrigation Paper, United States Geological Survey, No. 193.

fWater Supply and Irrigation Paper, United States Geological Survey, No. 200.

gJour. Assn. Engr. Socs., Vol. XIII, No. 7, July, 1894.

gJour. American Water Works Association, 1903.

tion of many representative sources of water supply in these States.

The municipal supplies are obtained from the Great Lakes, rivers, and from wells. The surface waters from the Great Lakes and rivers furnish the greater part of the water, though not the greater number of supplies. In Illinois, 60 of the 227 cities having general water supplies obtain such a supply from rivers, lakes or ponds, yet only two cities which contained more than 10,000 inhabitants in 1900. rely entirely on well waters for their water supply. Similar conditions exist in Minnesota. While only 25 per cent. of the supplies are from surface sources, the larger cities use such water.* In Wisconsin also, only 25 per cent. of the towns from which reports were obtained† use surface water, yet only four of the larger cities use well water exclusively, and several have changed recently. In Michigan‡ only five cities with more than 10,000 inhabitants obtain their water supplies from wells.

This is easily explained, because settlements are usually located on some stream or body of water, and because the growth is dependent on the abundance of the water supply. If a city located on the lake obtains a water supply at a distance from the shore, from a point where the current is flowing by the city, it was supposed that pure water would be obtained. The supposition is shown to be false by the experience of Chicago, where extending the intakes farther and farther into the lake failed to give a pure water; and in Michigan, where the worst typhoid epidemics in the State have occurred in cities obtaining water from the Great Lakes. When it is apparently necessary for a city to take its water supply from the lake and empty the sewage nearby, the water supply necessarily becomes pol-

*Water Supply and Irrigation Paper No. 193, p. 150, U. S. G. S.
†Bulletin University of Wisconsin, No. 106, p. 242.
‡Water Supply and Irrigation Paper No. 18, p. 24, U. S. G. S.

luted. Chicago is so conveniently located that the construction of the drainage canal has carried away the sewage and has given the city a purer water, and has decreased the typhoid rate to less than 20 per 100,000 in the years 1904-6. Yet Chicago, with no sewage entering the lake within the city limits, is at the present time troubled by the prospects of sewage from neighboring cities. The typhoid rate in northern Indiana lake towns is much higher than in Chicago, and investigation of the water furnished to the cities of Illinois north of Chicago shows that untreated water is unsafe for use. A filtration plant at Kenilworth gives a very satisfactory water. This plant should serve as an example for cities, not only of Illinois, but of the other States along the lake, which can undoubtedly obtain a satisfactory supply of water from the lake when proper precautions are taken. The appointment recently of the Lake Michigan Pure Water Commission, of which Dr. W. A. Evans, the Commissioner of Health of Chicago, is president, to study conditions in Lake Michigan, is a step in the right direction.

Owing to the density of the population in the State, none of the rivers or streams can be used for drinking purposes without treatment. The same is true to a great extent in the other States. In parts of Minnesota, Wisconsin and Michigan the population is not so great, but the water is often highly colored. The methods of treatment available are sedimentation and filtration, in combination of the two, and with or without the use of a coagulant. Sedimentation alone is difficult owing to the character of the suspended matter. A trial at St. Louis showed it to be unsatisfactory, and at the present time a coagulant is added with good results.* In Illinois one slow sand filter is in operation at Rock Island, but owing to the large amount of sediment carried by the water of the Mississippi river, it is not successful. Slow sand filters are not to be recommended for the southern

*Trans. Am. Soc. Civil Engineers, LX, 170 (1908).

part of this region. They have been recommended for Minneapolis, Minnesota, and Grand Rapids, Michigan. In neither case is the turbidity as high as in the streams in the more southerly part of the region. The majority of the plants use mechanical gravity filters with sulphate of aluminium or lime, and sulphate of iron or lime and sulphate of aluminium as coagulants. By this system very satisfactory results can be obtained. The difficulty with these plants is that the running is often too mechanical, and not enough attention is paid to the varying conditions in the rivers or to a control of the effluent. The control of water supplies from the lake or rivers requires precautions to prevent pollution, and especial care in the chemical, and especially the bacteriological control of the water as it enters the mains either from the lake or from the filter plants. Every plant should have a chemical and bacteriological control of its water supply. Plants which use 1,000,000 gallons or more a day could, we believe, profitably support a laboratory. Here determinations can easily be made of the color, turbidity, and alkalinity on which the amount of coagulant to be used is based; and simple bacteriological tests will show the character of the effluent. Some of the companies which own several plants have their own experts who go from plant to plant examining the water of each at stated intervals. Several independent plants could join in the employment of such an expert who would give directions for routine tests to be made by the regular employee, and would make check tests at stated intervals. The number of consumers in a town where a clear, pure water is furnished are proportionately more numerous than where the water is turbid. Many people will use the clear, probably polluted, shallow well water in preference to a turbid or colored, though pure, city supply. Those who can afford it use bottled water rather than a poor city supply. I am indebted to Professor McKee of Lake Forest University for the state-

ment that three grocers in Lake Forest, Illinois, sold $9,600 worth of bottled water during 1907. Much of this money would have been saved or would have gone to the water company had the supply been satisfactory in all particulars.

It has been noted that a large percentage of the municipalities are supplied by water from wells. These wells may in general be divided into wells in rock, and wells in drift. While all the States have both classes of water, the problems differ materially acording to the location. In Michigan, Indiana, Illinois, Iowa and Missouri some of the deep rock wells furnish brines, or waters containing so much mineral matter that they are unfit for municipal supplies. The probability of a locality furnishing a satisfactory water from deep wells is quite well established by test wells covering practically all of the territory. The most widely distributed water-bearing strata are the St. Peters and Potsdam sandstone. These, outcropping in southern Minnesota and Wisconsin, dip to the south and furnish deep well water in Minnesota, Iowa, Wisconsin, Illinois, Missouri, and Indiana. To the south, the water from both strata becomes impregnated with salts, so that it is unsatisfactory for use for drinking purposes. In Illinois the line below which the waters are unsatisfactory for drinking purposes extends from near the southern extremity of Lake Michigan to Quincy. If the Illinois observations are borne out in the other States, satisfactory waters should be furnished in southern Wisconsin, in most of Iowa, and in northern Missouri.

Large portions of all the States in question are covered with glacial drift. A driftless area is found in Missouri, Illinois, southwestern Wisconsin, northeastern Iowa, and southeastern Minnesota. In the remainder of the States the drift varies in thickness from 5 to 300 feet, and in many cases there are pockets of greater or less extent containing water. This water is usually hard; in places containing an excess of carbonates, and in other places containing an excess

of sulphates. Water from both the rock and the drift wells when carefully cased contains no pathogenic germs, but in nearly all cases is harder than water from streams. When sufficiently soft, these wells furnish an ideal water supply for small towns. As mentioned before, the supply is usually inadequate for the needs of the greater municipalities. Trouble is sometimes experienced because of the presence of soluble salts of iron, which on exposure to the air are precipitated, and decolorize white earthenware. Attempts have been made to prevent this trouble by aeration and sedimentation, quite successfully at Elgin and Freeport, Illinois.

In all the States probably a majority of the population obtain water from shallow wells. A campaign of education is needed to cause the abandonment of these wells wherever another and better supply is available, or to teach the owners of the wells the proper method of constructing and caring for them. Recently the State Water Survey of Illinois caused samples of water to be collected from farm wells in five widely separated portions of the State. The conditions found were, on the whole, better than had been expected. At Elgin, near the northern part of the State, the majority of the ten farms visited obtained their water from wells in rock, about 175 feet deep. Chemically, the water was of fair quality, and from a bacteriological standpoint excellent. At Kankakee, about 60 miles south of Elgin, the majority of the wells examined were drilled in rock to a depth of from 30 to 60 feet. These wells furnished a water of good character, both chemically and bacterially. At Champaign, about 70 miles south of Kankakee, the majority of the wells were bored in the drift to a depth of from 150 feet to 170 feet, and furnished a water free from bacteria, though containing a considerable quantity of alkaline earth carbonates. At Centralia, about 100 miles south of Champaign, the most unsatisfactory conditions were found. All the wells examined were shallow dug wells, none of which were entirely

satisfactory for drinking purposes. At Cairo, in the extreme southern portions of the State, about 70 miles south of Centralia, the majority of the wells examined were driven in the alluvial drift, and while containing considerable iron, furnished a water that was hygienically good. In four of the five portions of the State in which investigations were made, the problem of obtaining pure water on the farms is a simple one. The deep well in rock or drift furnishes a satisfactory water supply. The condition at Centralia is undoubtedly typical of a considerable portion of the south central part of the State where very deep wells would furnish a brine, and where there is not enough water-bearing sand to allow driven, drilled, or bored wells, to be successfully used. In such cases there is great need of care to see that the dug wells are carefully located away from privies, cesspools or other sources of contamination, and that they be carefully cased and curbed to shut out all surface water.

Our conclusions concerning the water problems of Illinois, and, to a certain extent, of the neighboring States, may be briefly summarized as follows:

Lake water furnishes an abundant supply, the quantity of which will be excellent, providing proper precautions are taken to prevent the access of sewage, and to properly purify it before it enters the mains.

All river water must be purified in some way; in the northern portion of the district by slow sand filters; in the southern portion by coagulation and sedimentation and rapid filters.

The deep wells furnish an ideal supply for the smaller municipalities, provided they do not contain too much mineral matter and the iron content is low or may be removed.

The individual supply on the farm in portions of the district may be obtained from deep wells. In other portions care must be taken that the shallow dug wells be properly located and constructed.

WATER PROBLEMS OF THE MIDDLE WEST*

By Dr. R. J. MANION
Fort William, Ont.

The city of Fort William, Ontario, is situated on alluvial soil, north of the Kaministiquia river, and being only a few feet above the level of the river and very flat, sewage is rendered somewhat difficult to handle.

It has not been exactly a boom town, but it has grown very rapidly, and I can remember only a few years ago when water was delivered for all purposes by wagons which were filled on the banks of the Kaministiquia river with pails, the handiest spot being chosen, little heed being given to sewage contamination. The water was then sold to the citizens at fifteen or twenty cents per barrel.

Ten years ago, as the city became of greater size and importance, a water works system was installed. To take water from Lake Superior or Loch Lomond would have greatly increased the cost of the system, so it was decided to go on using the Kaministiquia water, more particularly since it had been used for years and no markedly ill effects caused by it, as Fort William, up to the time of the great epidemic in 1906, was a very healthy town. A pumping station was built on the bank of the river, just above the most populous part, but not above the whole town, and the intake pipe was made to reach for some distance up stream. Although this could not be claimed to be an absolutely pure water it was *at that time* a good water, as the river ran through a very thinly populated part of the country.

*Read before the American Public Health Association at Winnipeg, August, 1908.

As years passed, the city grew greatly in size, the part of the city above the intake pipe much more populous, the district more thickly settled, and gradually the water of the river became more and more polluted. Typhoid fever became little by little more prevalent, but as the increase was gradual it required an epidemic to awaken the citizens to their danger, and an awful awakening came.

The sewers from the west end of the city were emptying into the river above the intake pipe, and the population for twenty miles up the river had increased. To make matters worse, in the autumn of 1905 a steamer passing up the river dragging her anchor had broken the intake pipe about twelve feet from the shore, so that all the filth and sewage about the broken end was being sucked in and distributed by the city mains. The break was not discovered at first, and then there was some delay in its repair, as it was not repaired until about the end of January, 1906. Then it was only a matter of a little less pollution. By the end of 1905 typhoid was increasing so rapidly that notices were put up and a proclamation issued instructing every one to boil all drinking water. A well, 150 feet in depth, which had been bored before the water works system had been established, was re-opened. The well water is clear, hard and pure. It was delivered in wagons to the citizens free of charge, and the public were advised to use it alone for drinking purposes. Many disregarded these orders, some openly boasting of drinking river water. Of one prominent gentleman who asserted that he had never drunk anything but river water, it was said, that he had never drunk water in his life unless it was well diluted by good whiskey. The typhoid fever increased so rapidly that in seven days in February 161 cases were reported, and for the whole month 412 cases. Many practicing physicians were attacked.

It was during the latter part of February that I first practised in Fort William, and I believe I am within the

bounds when I say that for two months every physician in the city was attending from thirty to sixty patients per day. Dr. Douglas of Montreal arrived in the city the same day as I did, and he took charge of the outbreak for the city. He had all the houses where the disease broke out placarded, and had the inmates given all instructions as to isolation, disinfection, and so forth, to prevent other cases occurring. He insisted on all the physicians reporting new cases at once. He was assisted by Dr. Birdsall, Medical Health Officer, and the members of the Board of Health. He had the outbreak checked about the middle of April, after one of the worst epidemics in the history of Ontario.

Dr. Starkey, Professor of Hygiene in McGill University, Montreal, who was engaged on the recommendation of Dr. Hodgetts, I understand, to investigate this outbreak, gave in his report the following causes of the epidemic:

First, a polluted water supply.

Second, personal contact or personal infection.

Third, the unsanitary condition of the ground due to

(a) defective sewerage,
(b) the privy system,
(c) want of proper garbage disposal.

On August 1, following the outbreak, the medical health officer resigned and I was appointed. I continually kept before the public the importance of not using for drinking purposes unboiled water from any source except the deep well above mentioned. But despite all precautions, some 200 cases occurred between July 1, 1906, and January 1, 1907. The main cause of this was to my mind the carelessness of a great many people in neglecting to act on the advice, and in drinking the Kaministiquia water, which was still running through the taps. This carelessness was unnecessary, as the city was distributing free the pure water from the deep well.

The Board of Health has kept on from that time to the present impressing upon the citizens the importance of drinking unboiled only the well water, and gradually the whole city has realized how important is this advice, as the following figures will show.

Year	No. of cases	Deaths	Population.
Nov. 1, '05—Nov. 1, '06	900	90	9,000
" '06— " '07	77	9	12,000
" '07—Aug. 1, '08	9	0	15,000

i. e., the past nine months.

That is, during the year of the epidemic there was one case of typhoid in every ten and one death in every hundred people, whereas in the past nine months, only nine cases occurred with no deaths.

And the only change of importance was the carefulness of the citizens in regard to the water which they drank.

True, the sewerage system has been improved, the privy system lessened, a method of garbage disposal introduced, and dairymen and soft drink manufacturers instructed to use only the deep well water for cleaning their utensils, and so forth, but these are of minor importance in comparison to purer water being used for drinking purposes.

It is to be regretted that the city is still supplied from the same water source, except for the delivery wagons, as it was during the epidemic over two years ago. But this is the fault of accident.

As soon as the citizens had time to think they decided on procuring water from a more satisfactory source. As a temporary source it was decided to utilize Crescent lake, a small body of water about three miles from the city, and work was at once begun. But unfortunately, the Crescent lake scheme proved a failure, and so it has been necessary to wait till the permanent system was completed. For a

permanent source they had a choice of installing a filtration system and taking the water from Lake Superior, or, of getting a water pure at its source from Loch Lomond. As the latter scheme involved a much smaller outlay it was decided upon.

John Galt, the consulting engineer, of Toronto, whose advice was asked, spoke in favor of this scheme. He describes the lake in the following words: "Loch Lomond is situated about seven miles from the city, at an elevation of 333 feet above the Kaministiquia river. It is a beautiful body of soft, clear, pure water, free from all contamination, and a delightful water for all general and domestic purposes." Mr. Galt then gave the city the estimated cost and an outline of the necessary work.

The lake is about ten square miles in extent, and at some places is 200 feet deep. It is fed by an area of about fifty square miles, and it is situated on a plateau among a range of hills southwest of the city. It has no source of pollution so long as the watershed is protected.

Not only is the water of this lake perfect from a sanitary standpoint, but by damming the outlet at Carp river the supply would be abundant for a population of a quarter of a million.

This supply will be brought to the city by a natural gravitation system. But as the lake is on the other side of Mt. McKay, a tunnel one mile long and six feet square is being driven, and is nearly completed, through solid rock. A large reservoir has been built about one mile from the end of the tunnel, from which reservoir the water will be conveyed by cast iron piping under the river and distributed through the city mains, making it an engineering problem of large size. The work is being done under the supervision of H. Sydney Hancock, the city engineer, with the assistance of Captain John King.

DISEASES FOUND IN THE INTERIOR OF THE NORTHWEST OF CANADA*

Sanitary Precautions and Results

By Dr. J. H. O'DONNELL
Winnipeg, Manitoba

Ruperts Land comprised all that portion of the Northwest whose waters emptied into the Hudson Bay. The Hudson Bay Company were the sole governing body, civil and criminal. In the territories, the Hudson Bay Company had but trading rights, which practically covered everything, although all legal matters were attached to some of the Judicial Districts of Lower Canada, and Upper Canada before confederation, Quebec, and sent there for adjustment. The health of the population, so far as it was possible, depended entirely upon physicians brought into the country by the Hudson Bay Company, and as a rule they were men of culture and learned in their profession, which enabled them to make extensive and valuable observations.

The population, aside from the aboriginal tribes, consisted mainly of Scotch, French, English, and some Irish. The Scotch and Irish were descendants of the original Selkirk settlers, and some members of the Sixth Regiment that for a time were stationed on some of the lakes, taking their discharge.

The pure half-caste was, as a rule, a very healthy individual, the farther removed became less vigorous, and, as a rule, inherited the tubercular diathesis of the Indian

*Read before the American Public Health Association at Winnipeg, August, 1908.

mother; the same holds good in the admixture of races throughout all nationalities.

Far in the interior, scurvy was really a scourge, and became a menace to public health generally. When an error in diagnosis occurs, as I shall attempt to show, malignant smallpox may be *mistaken* for scurvy, and was the cause of a frightful epidemic among the Indians in the West, that nearly destroyed whole tribes, and was quelled with great difficulty, owing to the belief that the disease was brought to them by the white men, and it was, as we shall see.

In cases of malignant smallpox, we have much the same condition to be exhibited in scurvy. We have the same condition of the gums, vibices, hemorrhages from various parts of the body, the spots (or eruption) are flat, red blue, or purple, and contain blood or sanious ichor, in the place of pus, constituting the variola nigrae of Sydenham, the bloody smallpox of Mead. We have hemorrhages from the fauces, nose, the gums become spongy and bleed similar to the condition in scurvy, and in many cases of this form of the disease, the only feature of the malady developed or observable before death is the condition of the gums and fauces.

In 1870 smallpox broke out among the plain Indians of the West, and became epidemic. A physician was sent out from here by the Government to vaccinate them, and make all the necessary sanitary arrangements to check the progress of the disease.

At the time no trace whatever could be ascertained as to how the disease appeared, or from whence it came. There had been no persons from outside points for three months before the outbreak. The following spring, I was treating a case of pneumonia in the hospital. The man had been a miner in British Columbia, and with a small party had crossed the mountains and remained for some time near Edmonton. In speaking of the smallpox among the Indians, he said he could tell just where it came from. His state-

ment was that a young man of the party of miners who started to cross the Rocky Mountains to Saskatchewan, soon after starting became ill with what they all thought was scurvy; he became rapidly worse, and death came suddenly from hemorrhage. An Indian who was acting as a guide, and at the time was going to meet some hunters in the mountains, took an overcoat belonging to the dead man that had been used very little, and after assisting to bury the corpse, left the little party to visit the camp of the mountain trappers. This Indian sometime after appeared in a camp of Indians on the plains, who were relatives, wearing the coat that had belonged to the dead man. Within a fortnight after, several of the Indians were taken with smallpox of a grave type; death followed in more than half of the cases. The Indians became panic-stricken, and scattered in every direction, distributing the malady everywhere, and the result, of course, was very lamentable.

The suspected case of scurvy in the mountains was in reality smallpox, and the dead man's coat brought in by the Indian guide was put on by the brave to make a good impression among his people. The coat was the article which carried the infection that caused the death of so many Indians and many white people, who fell victims while striving to check the progress of the epidemic.

The following year when the plain hunters came to Fort Garry to sell the buffalo robes and small furs, although robes from the stricken districts were prohibited, many found their way in, and in one case I was sent with an officer and witnessed the destruction of four hundred robes. The authorities were so alarmed that they would not listen to the advice given by Dr. Bird and myself, to have them sterilized. They insisted on destruction, and they were burned.

Quite a long time having elapsed, and the epidemic having died out, a few bales of robes found their way to Winnipeg. They were prime robes, and were sold single or in pairs,

all being disposed of quickly to persons who could pay a high price. Soon after a young married man in St. Boniface became ill, and the cause was diagnosed scurvy. In conversation with the attending physician, when he mentioned that the gums were swollen and bled profusely on the slightest touch, I suggested isolation, as it might be malignant smallpox. The case terminated fatally within a few hours, and the doctor felt sure it was one of scurvy.

Within a few days his brother became ill; he had a high fever and violent delirium from the outset, and was sent to the hospital. I saw the case soon after his admission, and was satisfied it was smallpox. The delirium was constant. I warned them, unless carefully guarded, he would be likely to escape, which he afterwards did, and made his way in the darkness across the prairie until he fell from exhaustion and cold, and died. He was found twenty-four hours after. The eruption was then apparent almost all over the body. The two cases mentioned were sons of the late Commodore Kitson, St. Paul, Minnesota.

The Hudson Bay Company had in the interior and in the far North, different forts or posts, and some were designated "meat stations," that is where they had very little flour for bread, and their food consisted almost altogether of flesh meat. Other posts were known as "fish stations," where the food for the greater part of the year consisted of fish. The latter stations suffered less from disease than the former. In the part of the country where animal food was their principal food, they suffered from Bright's disease and diabetes, erysipelas, and hepatic inflammations and dysentery, occasionally of a bad type, and occasionally cases of rheumatism and pneumonia.

At the fish stations and surrounding country, they had very little renal affections, no albuminuria or diabetes, unless inflammatory conditions from cold, and occasional cases of renal calculi. They had skin affections in great variety.

From the "meat stations" persons thus suffering from renal or hepatic affections were usually sent to "fish stations," and very generally improved thereby. The skin affections in many instances were specific, the primary disease having been contracted prior to entering the country. Medical stores, of course, in such a remote place, were limited, and the cases were treated by the administration of "Donovan's Solution" and mercurial local applications.

Tubercular affections other than pulmonary were not frequent, rarely in joints, and when developed, a sequence of an injury, as a rule.

In the Selkirk settlement, when a youth developed phthisis, they were usually sent out with the plain hunters for a year or two, and in most cases recovered permanently. Goiter was common in families that spent most of their time trading with the Indians in the Saskatchewan country; so observable was it the case, that it was named and always spoken of by the Selkirk settlers, as the "Saskatchewan disease." Those affected that came to live here generally improved with no other treatment than boiling the water or precipitating the permanent hardness in any way. In the Selkirk settlement there were cases of epitheliomia, the exciting cause from smoking mostly. An occasional case of "charbon" was to be met with, which was well understood by the physicians here at the time. I was surprised to find the use of animal ligatures by the late Drs. William Cowan and Bird, the fine fibre of sinew sterilized by being immersed for a time in alcohol, ether and hot water. In amputations the ordinary charpie bandage was used to drive the blood up into the trunk—quite as good a thing as the Esmarch. The stump was washed with hot water, alcohol and ether, and good results were as common as now.

THE COMMERCIAL PASTEURIZATION OF MILK*.

By B. R. RICKARDS
Columbus, Ohio †

ABSTRACT

The pasteurization of milk is a subject which has received its due share of attention in the last few years. As a very natural sequence to the epidemic traced to milk and also due in part, no doubt, to the establishment of bacterial milk standards by health boards, we find an increasing tendency on the part of the milk producers and milk contractors or handlers toward the pasteurization of their product.

Three of our large contracting milk firms were in 1908 pasteurizing a large proportion of their milk, two pasteurizing practically all of their bottle trade, a third pasteurizing all his milk except that sold to milk peddlers.

Each of the three different firms pasteurizing milk for the Boston trade use a different make of machine, each machine being radically different from the others.

At least four visits were made to each concern for the purpose of taking samples. On each trip an average of twenty samples were taken, ten as the milk went into the machines, and ten as it came from the cooling apparatus, the time limit between the taking of the two sets of samples being adjusted as closely as was possible to the time

*Read before the American Public Health Association at Winnipeg, August, 1908.

*The collection of specimens and the laboratory work on which this paper is based was by W. M. Campbell, Milk Bacteriologist.

†Written while Director of the Boston Board of Health Laboratory.

necessary for the milk to pass through the apparatus, so that the same lot of milk, practically speaking, was tested before and after the process.

TABLE NO. 1.

Firm	No. of Samples Taken	Milk exposed to air during	Temperature			Time exposed to heat
			Before	During	After	
X	36	Entire process	38-50 F	154-160	43-48	Est. 3 min.
Y	40	Cooling only	47-54	140-148	48-50	20 "
Z	50	"	52-58	158-165	46-52	Est. 3-5 min.

It will be seen that the machines in which the milk is exposed to heat for a short period of time are heated to a higher temperature than the one which holds the milk for twenty minutes.

According to Rosenau* 140° F. for two minutes is sufficient to kill the diphtheria, typhoid and dysentery organisms, but at least twenty minutes at 140° F. are necessary to kill the bacilli of tuberculosis. A momentary exposure at 160° will, however, kill the latter.

It is evident, then, that as far as the organisms mentioned are concerned, with the possible exception of *B. tuberculosis*, the processes as ordinarily carried on are sufficient to kill, and we may safely infer that the infecting material from other diseases, such as scarlet fever, would also succumb. While the control of the temperature is left to human hands, however, there is likelihood of the temperature falling low enough at times to fail to kill and even acting to multiply the organisms. One instance of this will be noted later. In addition, one must bear in mind the possibility of infection of milk by handling subsequent to pasteurization.

* Bulletin 42. Hygienic Laboratory, U. S. P. H and M. H. S., p. 82.

Out of 125 samples taken at different times, only 22 samples, or 18 per cent., were below the limit of 500,000 bacteria per c. c. The average count of each dealer was above this limit. As samples were taken at different periods between the first of March and the middle of June, 1908, some allowance may be made for the extremely hot weather during the latter part of that time. It is, nevertheless, apparent that a certain proportion of the milk going into certain of the machines was of higher bacterial content than should be allowed to be pasteurized.

TABLE NO. II.

EFFECT OF PASTEURIZATION

Contractor	Total	Average count before pasteurization	Average count after pasteurization	% Efficiency	
X	27*	688,000	15,000	97.7	Based on all first day counts
Y	39	881,000	9,750	98.9	
Z	50	3,576,000	273,000	92.4	

The above table shows the amount of and percentage reduction by pasteurization in the number of bacteria contained in the milk. In a milk previously of high bacterial content, we have, after pasteurization, all the dead and disintegrating bodies of the bacteria, all the bacterial products previously formed in the milk and to some extent probably unchanged by the heating, plus in some cases an amount of cooked dung and dirt varying with the original condition

*In one set of experiments this pasteurizer was evidently not being run successfully, the pasteurizer acting not as such but as an incubator. For the sake of comparison this set of nine tests is omitted from the above table and given below.

Before pasteurizing	After pasteurizing	
716,000	2,196,000	Increase 30% (Approx.)

of the sample. By the reduction of the number of bacteria through the heating process, the criterion by which we now judge a dirty, old or improperly kept milk, is temporarily lost. It is undoubtedly true that what organisms are left multiply with greater rapidity than before in the pasteurized milk, as shown in the following table:

TABLE NO. III.

SHOWING RELATIVE INCREASE IN BACTERIA IN PASTEURIZED AND UNPASTEURIZED MILK AT ICE BOX TEMPERATURE

	Unpasteurized milk Average count	Pasteurized milk Average count	No. of Samples
1st day	1,087,000	44,000	
After 24 hours in ice chest	22,617,000	3,691,000	87 (based on those samples on which a 24 hr. count was obtained.)
% increase	2,100	8,400	
Ratio	1	4	

In other words, on the average, bacteria will increase four times as fast in pasteurized milk than in unpasteurized milk when kept twenty-four hours at the temperature of the ice box. This figure coincides almost exactly with that obtained by St. John and Pennington in Philadelphia.*

Pasteurized milk seems to keep longer, but eventually acquires a strong odor and really may be said to decompose rather than sour. In nearly every instance we found the pasteurized milk, though heavily loaded with bacteria, did not decompose until after the unpasteurized milk taken at the same time had curdled. That such milk is unfit for food—especially for babies—goes without saying.

*St. John and Pennington, Journal Infectious Diseases, Vol. 4, p. 647.

Effect of Pasteurization on the Bacterial Analysis of Milk

In addition to the fact that we are obliged to pass dirty milk recently pasteurized because of its low count, we have found during this investigation that pasteurization affects our results in two other ways. In the direct microscopic examination of the milk sediment we have been able by means of Dr. Slack's method to make a close estimation of the number of bacteria present, thus "passing" such samples as were evidently below the limit of 500,000 bacteria per c. c. At the same time samples showing streptococci, increased leucocytes or pus were detected. In pasteurized milk the leucocyte estimate is much larger on account of the greater precipitation of cells in milk that has been heated, this result confirming the results reported by Russell last year before the Laboratory Section of the American Public Health Association. We have also noticed a higher bacterial estimate as compared with plate counts from the heated milk. This is probably due to such milk containing a large number of dead bacteria or bacteria so affected by heat as to be incapable of reproduction.

SUMMARY.

1. A large amount of milk is pasteurized in Boston every day. Some of the milk of one contractor is pasteurized in the country and is again pasteurized here.
2. The amount of milk pasteurized is probably increasing.
3. Some of this milk is of very high bacterial content.
4. Bacteria will increase much faster in pasteurized than in unpasteurized milk.
5. The pasteurization of milk affects the microscopic estimate of bacteria and leucocytes.

CONCLUSIONS.

1. Commercial pasteurization of milk *without restriction*

puts a premium on dirty milk, since dirty and old milk, otherwise unsalable, can then be put on the market.

2. Pasteurized milk may well mean cooked dirt, cooked dung and cooked bacterial products, and the laboratory is powerless to detect it, unless apparent to the naked eye.

3. The commercial pasteurization as at present practised in Boston, probably would destroy all disease-producing organisms, with the possible exception of the bacilli of tuberculosis. The latter would probably be killed in the majority of instances. One machine only out of the three tested would be likely always to destroy the latter. The toxins produced by these and by the putrefactive organisms in dirty milk would undoubtedly escape unharmed and in many cases be capable of producing severe intestinal disturbances—especially in babies.

4. A false sense of security is undoubtedly conveyed by the term pasteurized milk. The lack of security may come from either improper pasteurization, the pasteurization of improperly handled milk or improper care of pasteurized milk.

5. The unrestricted pasteurization of improperly kept, old or dirty milk should be prevented by regulations or ordinances prohibiting the pasteurization of milk containing over a certain specified number of bacteria per cubic centimeter, the bacterial limit being set with due regard to local conditions, especially the distance from which the milk comes. Such regulation should, of course, be coupled with a regulation forbidding the sale of milk above the bacterial limit established.

6. The law should require that milk heated above 140° F.* should be marked heated or pasteurized milk. Pasteurized milk should not be sold as fresh milk.

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*The Massachusetts Legislature of 1908 passed an act requiring the labeling of all milk heated above 167° F. "Heated Milk." The law as it stands is useless.

The pasteurization of milk in itself is probably not a harmful process, and is, perhaps, to a certain extent a necessity under modern conditions in large cities, but *commercial* pasteurization should be carried on only under the most stringent supervision.

OFFICIAL REPORT OF THE PROCEEDINGS OF THE THIRTY-SIXTH ANNUAL MEETING HELD AT WINNIPEG, MANITOBA, AUGUST 25, 26, 27, 28, 1908.

TUESDAY, AUGUST 25.

The Association met at the Royal Alexandra Hotel, presided over by the President, Dr. Richard H. Lewis of Raleigh, North Carolina.

On motion of Professor Robinson the reading of the minutes of the thirty-fifth annual meeting was dispensed with.

The following new members were elected:

Baker, Thomas H., M.D., 1613 Story Avenue, Louisville, Ky.
Baton, Warren U. C., 340 Melwood Street, Pittsburg, Pa.
Bell, Fred C., 121 Carleton Street, Winnipeg, Manitoba.
Bell, Robert W., M.D., 51 St. Vincent Street, Toronto, Ont.
Bissonnette, P. J. L., M.D., St. Esprite, Quebec.
Bjornson, O., M.D., 620 McDermott Avenue, Winnipeg, Manitoba.
Black, William, M.D., 159 Edmonton Street, Winnipeg, Manitoba.
Bleile, Albert M., M.D., 218 King Avenue, Columbus, Ohio.
Bond, J. H. P., M.D., Bannatyn Avenue, Winnipeg, Manitoba.
Brown, Raymond, M.D., Main Street, Winnipeg, Manitoba.
Burridge, Arthur J., M.D., 125 Furby Street, Winnipeg, Manitoba.

Cadham, F. T., M.D., Main Street, Winnipeg, Manitoba.
Campbell, Alexander M., M.D., 95 Sherbrooke Street, Winnipeg, Manitoba.
Campbell, Spurgeon, M.D , 326 Somerset Block, Winnipeg, Manitoba.
Carpenter, Thomas B., M.D., 533 Franklin Street, Buffalo, N. Y.
Caulfield, Alfred A., M.D., corner Bloor and Yonge Streets, Toronto, Ont.
Chestnut, W., M.D., Sherbrooke Street, Winnipeg, Manitoba.
Chown, Henry H., M.D., Broadway, Winnipeg, Manitoba.
Cleghorn, I. M., M.D., Baldur, Manitoba.
Clock, Ralph O., M.D., 42 West Broad Street, Burlington, N. J.
Closson, Oliver E., Marietta, Pa.
Cobb, Charles H., Arcade Building, Kankakee, Ill.
Corbett, S. C., M.D., Armstrong's Point, Winnipeg, Manitoba.
Connell, Walter T., M.D., 11 Arch Street, Kingston, Ont.
Cornman, Ernest L., V.M.D., Marietta, Pa.
Cox, F. J. C., Main Street, Winnipeg, Manitoba.

Davidson, J. R., M.D. Broadway, Winnipeg, Manitoba.
del Raso, Emilo, M.D , Mexico City, Mexico.

Elkin, S. J., M.D., 222 Portage Avenue, Winnipeg, Manitoba.
Evans, Wm. Augustus, M.D., 103 State Street, Chicago, Ill.
Evans, W. Sanford, Edmonton Street, Winnipeg, Manitoba.
Fagan, C. J., M.D., Vancouver, B. C.
Fell, Alton S., M.D., 12 East State Street, Trenton, N. J.
Ferguson, Meade, Ph D., 1110 Capitol Street, Richmond, Va.

Foster, Walter B., M D., 6 East Grace Street, Richmond, Va.

Foyle, Timothy F., 142 Hudson Street, Newark, N. J.

Grice, Joseph, M.D., Portsmouth, Va.

Guerola, Nicolas, M.D., Mexico City, Mexico.

Gunn, J. A., M.D., General Hospital, Winnipeg, Manitoba.

Hall, Pearl M., M.D. 1607 Fremont Avenue North, Minneapolis, Minn.

Hamilton, T. Glenn, M.D., 264 Renton Avenue, Winnipeg, Manitoba.

Hamilton, William T., M.D., High River, Alberta, N. W. T.

Hanchett, Alfred P., M.D., 201 City National Bank Building, Council Bluffs, Iowa.

Harding, Harry A., N. Y. Agr. Experiment Station, Geneva, N. Y.

Harris, D. L., M.D., St. Louis, Mo.

Hastings, T. W., M D., 20th Street and 1st Avenue, New York, N. Y.

Holm, Marinus L., M.D., 316 Capitol Avenue, Lansing, Mich.

Houston, John, M.D., Cypress River, Manitoba.

Hudson, Arthur, 265 Washington Street, Newton, Mass.

Irving, L. E. W., M.D., Edmonton, Alberta, N. W. T.

Irving, J. F., Yorkton, Sask.

Jennings, Fred H., 121 South Pleasant Street, Watertown, N. Y.

Keator, Bruce S., M.D., Asbury Park, N. J.

Laberge, Louis, M.D., City Hall, Montreal, Quebec.

Lafferty, James D., M.D., 202 Seventh Avenue West, Calgary, Alberta.

Lambert, Joseph H. O., M.D., St. Boniface, Manitoba.

Leaman, A. G., 446 Arthur Street, Port Arthur, Ontario.

Lederer, Arthur, M.D., 4843 Langley Avenue, Chicago, Ill.
Leeming, John H., M.D., City Hall, Winnipeg, Manitoba.
Lopez, Miguel M., M.D., Guadalajara, Mexico.

McArthur, J. A., M.D., Canada Life Block, Winnipeg, Manitoba.
McClintock, Charles T., M.D., Detroit, Mich.
McGlaskan, C. C., 107 Tache Street, Winnipeg, Manitoba.
McKay, Hugh, Winnipeg, Manitoba.
McKay, W. J., M.D., Saskatoon, Sask.
McMunn, R. S., M.D., 180 Selkirk Avenue, Winnipeg, Manitoba.
McDonell, John, M.D., Royal Alexandra Hotel, Winnipeg, Manitoba.
Maclean, Neil J., M.D., 326 Somerset Building, Winnipeg, Manitoba.
Mason, Charles F., M.D., U. S. Army, Washington, D. C.
Meek, E. E., M.D., Virden, Manitoba.
Miller, Edgar C. L., M.D., 66 Rosedale Court, Detroit, Mich.
Milroy, Thomas M., M.D., Donald Street, Winnipeg, Manitoba.
Monfort, Wilson Forsythe, 77 May Street, St. Louis, Mo.
Marrion, R. J., M.D., May Street, Fort William, Ont.
Moody, A. W., M.D., 156 Donald Street, Winnipeg, Manitoba.

Newton, McGuire, M.D., 1010 Floyd Avenue, Richmond, Va.
Nims, Boyden, Room 20 Kendall Building, Columbia, S. C.
North, Charles E., M.D., 39 West 38th Street, New York, N. Y.

O'Donnell, John H., M.D., Portage Avenue, Winnepeg, Manitoba.
Owens, R. B., C.E., Edmonton, Alberta, N. W. T.

Patterson, James, M.D., Donald Street, Winnipeg, Manitoba.
Perrow, Mosby G., Lynchburg, Va.
Philbrick, Burton G., 1014 Broadway, Oakland, Cal.
Pierce, S. J. S., M.D., Donald Street, Winnipeg, Manitoba.
Popham, E. S., M.D., corner Ellice and Hargrave Streets, Winnipeg, Manitoba.
Prouse, Samuel W., M.D., 497 River Avenue, Winnipeg, Manitoba.
Puchot, Gaston, M.D., Matamoras, Tamaulipas, Mexico.

Ranshaw, Willis W., M.D., 805 Madison Street, Covington, Ky.
Rattan, Henry N., City Hall, Winnipeg, Manitoba.
Ritchie, John, Jr., Old Court House, Boston, Mass.
Rogers, W., M.D., corner of Main and Portage Streets, Winnipeg, Manitoba.
Ross, D. G., M.D., Selkirk, Manitoba.
Ruediger, Gustav F., M.D., Grand Forks, N. D.

Santee, Ellis M., M.D., 23 Groton Avenue, Cortland, N. Y.
Schneider, Franz, Jr., 36 Summer Street, Lawrence, Mass.
Seymour, Maurice M., M.D., Regina, Sask.
Smith, W. Harvey, M.D., 223 Roslyn Road, Winnipeg, Manitoba.
Stewart, D. A., M.D., General Hospital, Winnipeg, Manitoba.
Taylor, William E., 515 Ohio Street, Terre Haute, Ind.

Thomas, Louis A., M.D., State House, Des Moines, Iowa.
Todd, J. O., M.D., Hargrave and York Streets, Winnipeg, Manitoba.

Underhill, Frederic T., M.D., Vancouver, B. C.
Uribe, Esteban, M.D., Toluca, Mexico.

Vrooman, C. H., M.D., 381 William Avenue, Winnipeg, Manitoba.

Wadge, Herbert W., M.D., 754 Logan Avenue, Winnipeg, Manitoba.

Warren, George L., M.D., 77 Houston Street, Newark, N. J.

Watkins, Frank L., M.D., 515 Harrison Building, Columbus, Ohio.

Whitelaw, T. H., M. D., 408 Third Street, Edmonton, Alberta, N. W. T.

Wilson, Thomas, City Hall, Winnipeg, Manitoba.

Following the reading of the report of the Committee on Ophthalmia Neonatorum by Dr. F. Park Lewis, Dr. Hurty was requested by the President to prepare a resolution relative to the publication of the report.

Following the papers and discussion on vaccination and smallpox, Dr. W. A. Evans of Chicago, Ill., moved that a committee be appointed to prepare an argument as to the efficacy of vaccination and that the American Public Health Association devise some means for dissemination of the report, and that some effort be made toward a simultaneous and concerted movement throughout the country in opposition to the anti-vaccination movement.

At the evening session of this day the President read his annual address.

WEDNESDAY, AUGUST 26th.

The Secretary announced that the Executive Committee had approved the constitution of the Section of Municipal Health Officers and recommended the same to the Association for adoption. The constitution was read by Dr. H. W. Hill, and on motion of Dr. Hurty, duly seconded, the same was adopted.

The new Constitution and By-Laws for the Association were then read by Professor Robinson and referred to a subsequent session for a vote.

The Treasurer, Dr. Frank W. Wright, presented the following report:

RECEIPTS.

1907		
October 3.	Cash on hand	$1,746.10
	Received from dues for 1905	5.00
	Received from dues for 1906	130.00
	Received from dues for 1907	2,010.00
	Received from dues for 1908	35.00
	Received from sale of Transactions	359.05
		$4,285.15

DISBURSEMENTS.

1907.			Order No.	Amount
October	15.	C. O. Probst	246	$87.35
"	30.	Frank W. Wright	247	94.68
"	30.	American Express Co.	248	28.85
"	30.	U. S. Express Co.	249	31.64
"	30.	Adams Express Co. ...	250	24.33
"	30.	Wells-Fargo Co. Ex. ...	251	32.02
December	7.	F. J. Heer Printing Co.	252	1,168.50
"	7.	Globe Printing Co. ...	253	14.00
"	7.	F. L. Covell	254	3.00
"	7.	H. W. Hill	255	25.85
"	7.	Nora C. O'Donoghue...	256	13.00
"	7.	William Whitford	257	215.15
"	7.	Adams Express Co. ...	258	5.62
"	7.	Wells-Fargo Ex. Co...	259	3.57
"	13.	American Journal Public Hygiene	260	125.00
1908				
March	7.	W. B. Gray	261	5.00
"	7.	John A. Hauff	262	15.00
"	7.	Dr. M. G. Overlock ..	263	5.00

April	7.	N. J. Bartlett & Co....	264	1.25
"	7.	American Journal Public Hygiene	265	125.00
June	1.	Adams Express Co....	266	21.58
"	1.	U. S. Express Co.....	267	18.69
"	1.	Wells-Fargo Co. Ex...	268	24.81
"	1.	American Express Co..	269	22.38
"	1.	Frank C. McElroy	270	13.50
"	1.	G. E. Stechert & Co....	271	13.50
"	1.	F. J. Heer Printing Co.	272	739.29
July	2.	American Journal Public Hygiene	273	150.00
"	2.	F. J. Heer Printing Co.	274	25.00
"	8.	H. W. Hill	275	69.05
"	8.	F. C. Robinson	276	12.00
"	8.	C. O. Probst	277	300.00
"	28.	Frank W. Wright	278	30.00
"	28.	American Journal Public Hygiene	279	205.00
August	1.	Balance on hand		616.54
				$4,285.15

On motion of Dr. Hodgetts the report of the Treasurer was referred to an Auditing Committee. The President appointed on this committee, Prof. Edward Bartow, Dr. William Delano and Mr. B. R. Rickards.

THURSDAY, AUGUST 27th.

The Secretary reported that the Executive Committee recommended the adoption of the motion by Dr. Evans in re a committee on vaccination with the further recommendations that a committee of seven members be appointed to carry out the provisions of the resolution.

On motion of Prof. Robinson the Association adopted the resolution and recommendations of the Executive Committee.

The Executive Committee reported back the following resolution offered and approved by the Section on Vital Statistics with the recommendation that it be carried.

Resolved, That the draft of a model law for the registration of births and deaths in the United States, based upon the essential requirements of registration as laid down by the American Public Health Association in conjunction with the United States Bureau of Census, and approved by the American Medical Association (and by the Conference of Commissioners on Uniform State Laws), be cordially endorsed by the American Public Health Association, and that the Committee on Legislation of the Section on Vital Statistics be authorized to co-operate on behalf of this Association with the representatives of the other organizations named, and with the Bureau of Census in making such minor changes as may be necessary and in urging the adoption of such legislation in non-registration States.

On motion the resolution was adopted.

The Secretary announced that the Executive Committee had considered the recommendation in the President's address that a committee be appointed, residents of the United States, for consultation and co-operation with the Natural Resources Commission, and recommended that such a committee be appointed from the Association for co-operation.

On motion the recommendation was adopted.

The Executive Committee recommended the appointment of an historian of the Association, and recommended Dr. William Bailey, of Louisville, Kentucky, for the position.

On motion of Dr. Baker, of Louisville, the recommendation was adopted.

The Executive Committee recommended that a Committee on Necrology be appointed as a new committee of the Association. On motion of Dr. Hill the recommendation of the Executive Committee was adopted.

The Auditing Committee submitted the following report:

"Your committee has examined the books and vouchers of the Treasurer and found them correct.

(Signed) EDWARD BARTOW.
B. R. RICKARDS
WILLIAM DELANO

On motion of Dr. Stanton the report of the committee was accepted and the committee discharged.

Dr. H. W. Hill presented the following resolution relative to publication of a journal:

WHEREAS. Public hygiene, originating as a side growth from the observations of therapeutists, engaged in treating the sick, has through general scientific advance, particularly in vital statistics, bacteriology, chemistry, engineering and other related technicalities, become a definite and distinct scientific profession.

And WHEREAS, The professional public hygienist, who has pushed steadily forward, through the years of inevitable mistake, misunderstanding, neglect and disdain incident to the birth of a new science, now sees in the developments of the last two years a most striking and widespread recognition and appreciation of the enormous importance of public hygiene.

And WHEREAS, The American Public Health Association, alone amongst the national or international medical or scientific organizations of this continent, has for thirty-six years consistently fostered public hygiene, by affording a

place of conference, a rallying point for mutual encouragement, a mouthpiece for hygienic endeavor, warning and advice, and a centre for the unification of methods and advance in practice.

And WHEREAS, Notwithstanding the critical professional responsibilities and the large statutory powers of the professional public hygienist, demonstrated most prominently in handling epidemics, but also day by day in the less spectacular but far more important matter of *preventing* epidemics as well as in improving the physical conditions of life of the everyday citizen, and notwithstanding that the professional public hygienist is a most important factor in modern community life, yet the members of this profession, necessarily few in numbers and widely scattered, lack the hearty fraternal support and encouragement in their daily work which other professions, having many members in each community, may freely enjoy.

And WHEREAS, In other professions, individual effort reaps a reward in individual advance, but in professional public hygiene, individual effort reacts chiefly upon the advance of the community, and seldom secures financial or professional advance to the individual concerned.

Be it resolved: 1. That the profession of public hygiene presents many features sharply distinct from those presented by the other professions.

2. That the opportunity for interchange of thought, for consultation and conference, even for securing, through reading, a knowledge of current practice and new developments, for long open to other professions, is almost wholly lacking to the professional public hygienist, because of his relative isolation and because of the comparative absence in this country of such literature.

3. That the isolation of the professional public hygienist is obviously irremediable, and makes the possession of high-

class professional literature even more important to him than to the physician, lawyer or engineer.

4. That a journal for public hygienists should therefore be established, that the very profession which peculiarly requires such a journal shall no longer be the only profession which does not possess one.

5. That the burden of the financial support of such a journal, readily borne in the case of other professions by subdivision of expense amongst their relatively numerous members, and properly borne by the individual member of such professions, because it reacts to his own personal advancement, should not be borne by the individual practitioner of public hygiene, because it is chiefly of value to the public, and cannot be so borne in any case because of the relatively small number of individuals amongst whom the expense must be divided.

6. That such a journal should be edited, controlled and published by profesional public hygienists, for professional public hygienists; and that it should therefore be under the direction and control of the one representative association of professional public hygienists, the American Public Health Association.

7. That the endowment of such a journal from private funds would afford to the donor a rare opportunity to serve the public interest in no less a manner than in the upbuilding and advance of that profession which now legally and actually is in charge of the public health and which is here and now daily concerned in the actual conduct of public health affairs throughout the communities of this continent.

8. That the committee representing this Association be authorized and instructed to lay this matter before such persons or agencies who, devoting themselves to the private financial support of public interests, have demonstrated by previous benefactions in other similar directions, a sympathy

with large practical movements for the upbuilding of the community, the nation and the race. Such committee to have full power to represent the Association and enter into legal agreements.

This resolution was referred to the Executive Committee to report back on Thursday.

Dr. John N. Hurty of Indianapolis offered the following resolution, which was referred to the Executive Committee:

Resolved, By the American Public Health Association, That it heartily recommends to the American Congress the passage of such legislation as is intended to enlarge the scope and increase the efficiency of the Public Health and Marine Hospital Service. To this end the Association believes the powers of the Service should be increased; that provisions should be made for the retirement under pay of the members of the Service, and that the salaries of the said members should be made commensurate with the Medical Service of the Army.

The Secretary shall send a copy of this resolution to the Chairman of the House Committee on Interstate and Foreign Commerce, and to the corresponding committee in the Senate.

Dr. Hurty presented the following resolution prepared at the request of the President:

Resolved, That the Secretary of this Association shall publish at the earliest possible date the report of the Committee on Ophthalmia Neonatorum in the Journal of the American Medical Association, or other medical journal, and that he shall have two thousand reprints made and distribute the same according to his judgment, subject to the approval of the Publication Committee.

The resolution was referred to the Executive Committee.

The following resolution by Dr. William A. Evans of

Chicago was recommended for adoption by the Executive Committee:

Resolved, That it is the sense of the American Public Health Association that in cities of 300,000 and over, the next census should be taken on the basis of city blocks.

[No subsequent action was taken on this resolution by the Executive Committee or the Association. The resolution was referred to the Committee of Seven for action, and by vote of this Committee was adopted, and a copy of the same was sent to the Bureau of the Census.—SECRETARY.]

Prof. Robinson presented the report of the Committee on Constitution and By-Laws. The constitution and by-laws were read section by section, amended and adopted.

Dr. Hurty then moved that the constitution as a whole be adopted, which motion was seconded and carried. On motion of Dr. Bryce, it was voted to put the constitution into effect immediately after the close of this meeting to the extent necessary to carry on the regular work of the Association. [The Constitution and By-Laws can be found in the Appendices to Vol. 34, Papers and Reports.]

Dr. Charles Wardell Stiles moved a vote of thanks to the Committee on Constitution and By-Laws. This motion was seconded and carried unanimously.

FRIDAY, AUGUST 28TH.

Following the reading of papers on typhoid fever, Dr. H. W. Hill moved the appointment of a committee to consider the question of typhoid in every respect, but particularly to agitate in every manner the reporting of cases of typhoid fever, and directing their efforts to the municipality, the health officers and the individual physician.

This motion was referred to the Executive Committee.

[No action was taken by the Executive Committee. The

motion was afterwards referred to the Committee of Seven and approved, and the President instructed to appoint a committee. This has been done.—SECRETARY.]

Prof. Robinson presented the following resolution of thanks, which was adpoted by a rising vote:

Resolved, That the thanks of this Association be hereby extended, first, to the Local Committee of Arrangements. This has been one of the most successful meetings of the Association ever held, and its success has been in a great measure due to the untiring work of this committee. When the pleasures of these days are in the future recalled to our minds they will always be associated with the names of Dr. Simpson, E. M. Wood and Dr. Douglas, and those others who have worked with them. The lady members of that committee are, of course, included in this vote; but we wish to specially emphasize our appreciation of the services they have rendered to the ladies of our party.

Resolved, In the second place, that we extend our hearty thanks to the provincial government, the city council, to the parks board, to the trustees of the general hospital, to the press of the city, and to all other organizations and individuals who have contributed to our enjoyment and profit. Under this last head are included especially those who have put their automobiles at our service, and the general manager of this magnificent hotel—Mr. Wills. We, of course, go away leaving you little money to enlarge the material side of your city; but we leave you our respect and love, both because we cannot help it, and because we would not if we could.

The Secretary reported that Dr. Hill's resolution relative to publication of journal had been approved by the Executive Committee and recommended for adoption.

It was moved and seconded that the action of the Executive Committee be concurred in. [The President has ap-

pointed a committee to carry out the provisions of the above resolution.—SECRETARY.]

The Secretary reported that the Executive Committee had recommended for adoption the resolution of Dr. Hurty, providing for the publication of the report of the Committee on Ophthalmia Neonatorum, subject to the approval of the Publication Committee.

On motion the recommendation was adopted.

The Secretary reported that the Executive Committee had recommended for adoption the resolution offered by Dr. Hurty (in re-endorsing legislation intended to enlarge the scope and increase the efficiency of the Public Health and Marine Hospital Service).

On motion the resolution was adopted.

The Secretary announced that the Executive Committee is empowered under the new constitution to appoint the Committee of Seven. It has done so, and this committee consists of the three ex-officio members, President, retiring President and Secretary, and the following appointed members: Dr. William C. Woodward, of Washington, D. C.; Professor Franklin C. Robinson, of Brunswick, Maine; Dr. Henry Mitchell, of Asbury Park, New Jersey, and Dr. John N. Hurty, of Indianapolis, Ind.

Dr. John F. Anderson of Washington offered the following amendment to the constitution and by-laws:

In Chapter Four, strike out the word "fifteen" between the words "to" and "minutes," and insert in place thereof the word "twenty."

This amendment was referred to the next meeting of the Association.

Dr. Charles A. Hodgetts presented the report of the Advisory Council as follows:

The Advisory Council presents the following as its report: President, Dr. Gardner T. Swarts of Providence, R.I.; First Vice-President, Dr. R. M. Simpson, of Winnipeg, Manitoba;

Second Vice-President, Dr. Jesus Chico, of Mexico; Third Vice-President, Major Charles F. Mason, U. S. Army, Washington, D. C.; Treasurer, Dr. Frank W. Wright, of New Haven, Conn.; Secretary, Dr. Charles O. Probst, of Columbus, Ohio; three members of the Executive Committee, Mr. James O. Jordan, of Boston, Mass.; Dr. William A. Evans, of Chicago, Ill., and Dr. A. J. Douglas of Winnipeg, Manitoba.

The Advisory Council recommends that Richmond, Va., be chosen as the next place of meeting.

On motion the report was adopted as read.

The following officers were submitted by the various Sections to the Association, with the recommendation that they be confirmed, and on motion they were all duly elected:

SECTION OF MUNICIPAL HEALTH OFFICERS.

Chairman, Dr. William C. Woodward, of Washington, D. C.; Vice-Chairman, Dr. A. J. Douglas, Winnipeg, Manitoba; Secretary, Dr. E. C. Levy, of Richmond, Va.; Recorder, Dr. Charles V. Chapin, of Providence, R. I.; Council, Dr. S. H. Durgin, of Boston, Mass.; Dr. M. S. Iglesias, of Vera Cruz, Mexico; Dr. William A. Evans, of Chicago, Ill.; Dr. T. H. Baker, of Louisville, Ky., and Dr. James Roberts, of Hamilton, Ontario.

LABORATORY SECTION.

Chairman, Dr. J. J. Kinyoun, of Washington, D. C.; Vice-Chairman, Dr. William Royal Stokes, of Baltimore, Md.; Secretary, Mr. B. R. Rickards, of Boston, Mass.; Recorder, Dr. H. D. Pease, of Albany, N. Y.; Council, Dr. H. W. Hill, of Minneapolis, Minn.; Dr. Edward Bartow, of Urbana, Ill.; Dr. B. H. Stone, of Burlington, Vt.; Dr. D. G. Revell, of Edmonton, Alberta, and Dr. E. C. Levy, of Richmond, Va.

SECTION OF VITAL STATISTICS.

Chairman, Dr. Charles A. Hodgetts, of Toronto, Ontario; Vice-Chairman, Dr. William H. Guilfoy, of New York City; Secretary, Dr. W. R. Batt, of Harrisburg, Pa.; Council, above and Dr. Jesus Chico, of Mexico; Mr. A. Blue, Ottawa, Ontario; Dr. M. L. Price, of Baltimore, Md.; Dr. William C. Woodward, of Washington, D. C.; Dr. John N. Hurty, of Indianapolis, Ind.; Dr. Cressy L. Wilbur, Honorary and Advisory Member, of Washington, D. C.

Dr. Henry Mitchell presented the report of the committee on the establishment of a journal with the following resolution which had been recommended by the Executive Committee for adoption.

WHEREAS, It appears from the report of the Treasurer that the funds of this Association, now in hand, are insufficient to permit of the publication of all the transactions of the present meeting; therefore, be it

Resolved, That the Publication Committee is hereby authorized to expend the sum which is available, and which may be appropriated by the Committee of Seven for the publication and distribution of the proceedings of the Winnipeg meeting, in full or in abstract, in such form as the said Publication Committee may deem best.

On motion of Dr. Hill the resolution was adopted.

On motion of Dr. Hodgetts the report of the Committee was accepted and the members of the Committee thanked and discharged.

The President stated Dr. Kohnke, chairman of Committee on Relief of Family of James Carroll, would not be able to do the work, and that Dr. Kohnke had requested that another member be appointed in his place. The President suggested that the incoming President appoint such a member. On motion of Dr. Hodgetts the appointment of the member of the Committee was left to the incoming President.

There being no further business, the Association adjourned *sine die.*

C. O. PROBST, Secretary.

Attest.

The following papers, read at the meeting of the Laboratory Section at Winnipeg, were not received for publication:

Experimental Leucocytosis in the Cow's Udder, by Conrad Hoffman; The Individual Animal as a Factor in the Germ Control of Milk Supplies, by E. G. Hastings and Conrad Hoffman; The Waters of the Great Lakes, by R. B. Dole; Some Studies of the Physiological Leucocyte Content of Cow's Milk, by B. H. Stone and L. P. Sprague (Journal of Medical Research, 1909); A Comparison of Practical Methods for Determining the Practical Content of Milk (Journal of Infectious Diseases, Vol. V, page 412), by P. G. Heinemann.

The following Association papers were withdrawn from publication:

Report of the Committee on Ophthalmia Neonatorum, Dr. F. Park Lewis, Chairman, Buffalo, N. Y. (published in full in the Journal of American Medical Association, March 13, 1909, Vol. 52, p. 876).

"Water Problems of the Middle West," Dr. F. F. Westbrook, Minneapolis, Minn.

"Control by Patent of Sewage Disposal Methods," F. Herbert Snow, Harrisburg, Pa.

"Hookworm Disease," Dr. Chas. Wardell Stiles, Washington, D. C.

"The Diagnosis and Prevention of Smallpox in Ontario," Dr. James Roberts, Hamilton, Ontario.

Laboratory Section

ROUTINE COUNTS OF BACTERIA IN WATER * SUPPLIES

By KARL F. KELLERMAN and H. A. WHITTAKER

The routine bacteriological examination of a water supply must depend to a large extent upon the determination of the number of bacteria in a measured quantity of water. At best, this determination cannot be accurate, as the variety of the species in the water, the culture media employed for plating, the temperature of incubation, the time of incubation, and the skill of the manipulator, are all limiting factors of more or less importance. A long step toward securing comparable results was made when the Committee on Standard Methods of Water Analysis of the American Public Health Association issued their classic recommendations. Here, however, in accord with such authorities as Thresh, Mason, Horrocks, etc., gelatin is given the preferance over agar as the standard medium. The low temperature of incubation and therefore delayed results with this medium are objectionable. In the words of Gage "it is essential that the procedures be so modified that they shall yield more complete information regarding the various kinds of water bacteria under examination, and that they shall yield that information within a reasonably short time."

Heartily subscribing to this sentiment and emphasizing the paramount importance of total counts, especially for the examination and control of filters, we believe that plain beef

*Read before the Laboratory Section of the American Public Health Association at Winnipeg, August, 1908.

agar, made in accordance with the recommendations of the aforesaid Committee on Standard Methods of Water Analysis, is the most suitable medium for routine work, and that a temperature of from 28° to 30° C. is the best for incubation. At this temperature twenty-four hours gives a fairly high count, and forty-eight hours one considerably higher. Of course it is admitted that the terms "total counts of bacteria" are figures of speech—just as beef agar usually gives a higher count than beef gelatin, so does Nahrstoff agar (see Hess and Niedner) outcount beef agar; and other media might show still greater numbers.

The delay in securing results makes Nahrstoff undesirable, although there can be no doubt that as an indicator of conditions changing—and this is all we can expect of routine counts—it is much more sensitive than beef agar or beef gelatin. The accompanying curves show the results of comparative work over a considerable period, with different kinds of water. The lowest line is gelatin, according to the standard methods, the middle line is beef agar, forty-eight hours at 28-30°, and the top line Nahrstoff agar five days at 28-30°.

REFERENCES.

J. C. Thresh, The Examination of Waters and Water Supplies, p. 336, Philadelphia, Pa., 1904.

W. H. Horrocks, An Introduction to the Bacteriological Examination of Water, p. 10, London, 1901.

W. P. Mason, Examination of Water, p. 106, New York, 1899.

Stephen De M. Gage, On the Significance of the Numbers of Bacteria in Water and Sewage Developing at Different Temperatures. Report of State Board of Health of Massachusetts, 1906, pp. 327-349.

Dr. W. Hesse and Dr. Niedner, Die Quantitative Bestimuning von Bakterein in Fluesigkectin. Zeit fur Hygiene, Vol. 53, pp. 259-280, 1906.

DETERMINATION OF NITRATES BY REDUCTION WITH ALUMINUM*

By EDWARD BARTOW and JEROME STANLEY ROGERS

The work described in this paper was begun with the intention of making a comparison of various methods for the determination of nitrogen as nitrates; but after a few preliminary tests and also because we noted that E. M. Chamot of Cornell University had prepared a paper on the phenol sulphonic acid method, it was determined to confine the experiments almost entirely to a study of the method which depends upon the reduction of nitrates by means of aluminium.

The first series of the preliminary tests were made on a series of ten waters chosen from the routine samples of the State Water Survey Laboratory. These, according to the analysis made by the method in use in the laboratory, contained nitrogen as nitrates in varying amounts from 0.00 to 72.0 parts per million. These ten waters were then analyzed for nitrogen as nitrates by the aluminium reduction method, by the phenol sulphonic acid method and by the Brucine method of Noll.

An examination of the results showed that the amount of nitrogen found by the various methods was not the same. The Brucine method gave the lowest results and the phenol sulphonic acid method the highest. Especially was this true of the samples containing the larger amounts.

Since we could not be certain which method gave the

*Read before the Laboratory Section of the American Public Health Association at Winnipeg, August, 1908.

correct results when waters containing unknown quantities of nitrogen as nitrates were used, the second series of preliminary tests was run on ten samples of water containing known quantities of nitrogen as nitrates in amounts varying from .05 to 50.0 parts per million. Duplicate analyses were made by the phenol sulphonic method* and triplicate analyses by both the Brucine and aluminium reduction methods. The aluminium reduction method gave high results in the tests of samples which contained less than .5 parts per million and low results in all tests in which one or more parts per million was present. In these latter results there was a recovery of only 80 to 90% of the nitrogen placed in the sample. The phenol sulphonic acid method gave high results in most of the determinations. A few of the determinations, however, were low. The check analyses differed considerably from each other. The Brucine sulphuric acid method in the majority of the tests gave low results. This was especially true of the samples containing the larger quantities of nitrogen as nitrates. These results as a rule were lower even than those obtained by the aluminium reduction method. We did not feel that the results we obtained by any of the methods were entirely satisfactory.

Since Professor E. M. Chamot of Cornell was investigating the phenol sulphonic acid method, and since the aluminium reduction method has been in use in this laboratory almost exclusively since the organization of the Survey, it was decided to determine, if possible, the cause of the high results in the samples containing low nitrogen and the low results in the samples containing the larger quantities.

The best discussion of this aluminium reduction is that of Hazen and Clark, and our results are in many respects in accord with theirs, though differing in some features.

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*Standard Methods of Water Analysis, p. 40.

† Chem. News, LXIV, 162.

Experiments were planned with a view to determining the effect of temperature upon the reduction, and of time on the completeness of the reaction. A solution containing 10 parts per million of nitrogen as nitrates was prepared. To portions of 100 c.c. each of this solution was added two c.c. of a 40 per cent. solution of sodium hydroxide, free from nitrates. The solution was concentrated to 15 to 20 c.c., the residue was washed into a test tube holding approximately 100 c.c. and was then diluted to about 75 c.c. with nitrate free water and a strip of aluminium added. Eight of these samples were allowed to stand at room temperature; eight in the incubator at about 37½°, and eight in the ice box at a temperature of from 5 to 8° C. At the end of sixteen hours half of the samples were diluted with 250 c.c. of distilled water, and the ammonia formed was distilled over and determined. The remainder of the samples were treated in the same way at the end of thirty-two hours. We noted that the longer the solutions were allowed to stand the less nitrogen as nitrates was recovered. We noted also that the largest amount of nitrogen was recovered when the reduction took place at the temperature of the ice box, and the smallest amount of nitrogen at a temperature of from 35 to 40° C. This agrees as far as temperature is concerned with the results obtained by Hazen and Clark.

Two of the solutions were nesslerized directly after dilution to 200 c.c., and the results agreed so closely with results obtained by distillation that in subsequent tests on standard solutions we estimated the nitrogen by direct nesslerization.

The low nitrogen would hardly be accounted for by a failure to reduce all the nitrates present as the results were lower when the solutions were kept the longer. We therefore next sought to determine the amount of nitrogen which was probably carried off as ammonia gas.

A series of experiments was planned in which four solu-

tions were run at room temperature; four at the temperature of the incubator, 37½°; and four in the ice box at the temperature of from 5 to 10° C. 100 c.c. of the standard solution containing 10 parts per million of nitrogen as nitrate were used in each case. Each solution was prepared as in the preceding experiment, and in addition the mouth of the test tube was closed with a rubber cork, through which passed a U-shaped glass tube of such a length that the outlet could be placed in a second test tube containing a small amount of dilute hydrochloric acid which served as a trap to catch any ammonia that might escape. The traps were changed at the end of each hour for six hours, and the ammonia caught in the traps was determined by direct nesslerization. Very little ammonia passed off. The average for the samples at the temperature in the ice box was .01 parts per million; for the samples at room temperature the average was .09 parts per million; and for the samples at 37½° the average was .21 parts per million. The amount found in the traps in no way agreed with the amount not recovered in the previous experiments.

The ammonia was determined in the reduction tube after a total period of 20 hours. At room temperature the average for the four solutions was 9.6. At the temperature of 37½° the average was 10.0. At the temperature of the ice box the average was 9.4. If to this we add the ammonia found in the traps the total amount recovered is slightly more than 10 parts per million. The excess was practically equal to the test of our distilled water and reagents. We were surprised at the results of this experiment, for we expected to find considerable ammonia in the traps, whereas practically none was found. We feel that this fact can be explained on the supposition that ammonia is carried out of the solution by the hydrogen evolved. When no traps are used the light gases diffuse quickly, whereas when the trap is used diffusion is slow. The more soluble ammonia

is re-dissolved by the liquid while the hydrogen alone passes out through the trap. The results indicate that the temperature at which the reduction takes place is of little importance provided care is taken to prevent diffusion of the light gases.

We next carried out a series of experiments to compare directly the results of reduction with and without traps and to confirm the results of the two preceding series. The same standard solution was used and the tests were made the same as before. With traps, at room temperature, 9.8 parts per million of nitrogen as nitrates was recovered from the reduction tube and 0.09 from the trap, making a total recovery of 9.89 parts per million, whereas when the traps were not used only 6.0 parts per million were recovered.

With traps, at a temperature of $37\frac{1}{2}°$, 10 parts per million were recovered from the reduction tube and .14 from the traps, whereas when the traps were not used only 4.6 parts per million were recovered.

With traps, at the temperature of the ice box, 10 parts per million were recovered from the reduction tube and .06 parts per million from the traps, whereas from the tubes without traps only 8.2 parts per million were recovered. These results confirmed our former conclusions.

One of the objections to the aluminium reduction method lies in the fact that considerable time is required for the completion of the reaction. It has been customary to allow the reduction to go on over night. We arranged tests to determine the time at which the reaction would be completed. We first planned five series of four tests each, in which the reduction would run for periods of 2, 4, 6, 8 and 10 hours at room temperature. We used a solution of the same strength as before, containing 10 parts per million of nitrogen as nitrates. Traps were used during the reduction and the ammonia formed was determined by direct nesslerization. At the end of two hours 7.7 parts per million of nitro-

gen were recovered from the solution tubes and .02 parts per million from the traps. At the end of four hours the reduction was evidently complete as 10.1 parts per million of nitrogen as ammonia was recovered from the solution tubes and .06 parts per million from the traps. The tests which ran 6, 8 and 10 hours gave practically the same results as the four-hour test. At the end of two hours nitrites amounting to .02 parts per million were found.

Since at room temperature the reduction was completed in less than four hours, in the next series of tests, at a temperature of 37½°, it was arranged to test groups of samples of four each at the end of 1, 2, 3 and 4 hours. These tests were carried out in the same manner as the tests made at room temperature. At the end of one hour 4.6 parts per million of nitrogen were recovered from the solution tube and .01 parts per million from the traps. At the end of two hours 8.9 parts per million were recovered from the solution tubes and .03 parts per million from the traps. At the end of three hours 10.3 parts per million were recovered from the solution tubes and .03 parts per million from the traps.

There was a slight increase in the amount of nitrogen recovered at the end of the fourth hour. These tests indicate that the time required for solutions containing nitrates alone need not be as long as has been previously recommended.

Tests were next run with waters containing smaller amounts of nitrogen, namely, 0.5 and 2.5 parts per million. The tests were run by direct nesslerization at room temperature for four hours, using traps. The distilled water used contained .21 parts per million of nitrogen as nitrates which, after deduction from the amount of nitrogen recovered by the determination, gives .35 parts per million instead of .5 parts per million, and 2.34 parts per million instead of 2.5 parts per million.

A series of six determinations was run on waters which

had been analyzed by the regular routine of the laboratory. The determinations were made by direct nesslerization at room temperature after four hours' reduction, using traps. In each case a larger amount of nitrogen was recovered.

In No. I. 0.44 parts per million instead of .12 parts per million.

In No. II. 42.00 parts per million instead of 30.00 parts per million.

In No. III. 0.44 parts per million instead of .32 parts per million.

In No. IV. 30.00 parts per million instead of 25.00 parts per million.

In No. V. 6.8 parts per million instead of 4.20 parts per million.

In No. VI. 3.2 parts per million instead of 1.6 parts per million.

A series of analyses in which the amount of nitrogen was unknown to the analyst was next made at room temperature. The period of reduction was four hours, traps were used and the ammonia found was determined by direct nesslerization.

	Amount of nitrogen added.	Amount of nitrogen found.
I.	22 parts per million	24 parts per million
II.	10 parts per million	10.8 parts per million
III.	2 parts per million	2.8 parts per million
IV.	0 parts per million	.16 parts per million
V.	.28 parts per million	.4 parts per million

The foregoing series of experiments would indicate that nitrogen as nitrates should be recovered with a reasonable degree of accuracy from pure water to which nitrogen as nitrates had been added and from ordinary drinking water.

Since the phenol sulphonic acid method is said to be unsatisfactory for the determination of nitrogen as nitrates in sewages, it was decided to run a series of tests on sewages to which nitrogen as nitrates had been added. It is well

known that nitrates in sewages are very low. We made determinations of nitrogen as nitrates before and after the addition of 10 parts per million to each of three samples of sewage. These were the sewage of Urbana before and after it passed through the disposal works and the water from a polluted stream which passes through the University grounds.

In the first series of tests the analysis was made 24 hours after the nitrates were added. We recovered no more nitrogen as nitrates from the samples of sewage to which 10 parts per million had been added than from the original sewages. The ten parts per million of nitrogen as nitrates had entirely disappeared. The water from the polluted stream contained originally one part per million of nitrogen as nitrates. From the sample to which 10 parts per million had been added only 8 parts per million were recovered at the end of the four hours reduction period.

In order to check the results the work was repeated with similar results.

A series of analyses was then run immediately after the nitrates were added. Proceeding in this way 7.7 parts per million of nitrogen as nitrates were recovered from the raw sewage, to which 10 parts per million of nitrogen as nitrates had been added; 9.4 parts per million were recovered from the sewage which had passed through the disposal works; 8.7 parts per million were recovered from the polluted stream. Nitrites were found in all of the samples after four hours' reduction, indicating that the reduction was not yet complete. We conclude from this series of tests that in the presence of organic matter the reduction of nitrogen to ammonia is slower than when the organic matter is absent. We conclude also that it would be useless to make the determination of nitrogen as nitrates in raw sewage, and also in sewage which has passed through a solution chamber similar to the one at Urbana.

GENERAL SUMMARY.

1. Because of loss of ammonia the amount of ammonia recovered in a given time in open reduction tubes varies inversely with the temperature.

2. The loss of ammonia is prevented and the temperature has no effect if the hydrogen is allowed to escape through traps.

3. The reduction is completed in less than four hours in pure water or waters of average purity; in highly polluted waters the reduction requires longer time.

4. In sewage the determination of nitrogen as nitrates is practically without value because the nitrates are reduced by the oxidation of the organic matter present.

A STUDY OF CERTAIN PARACOLON FORMS FOUND IN POLLUTED DEEP WELLS*

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About August 1st, 1907, a new wing of the State Hospital for the insane at Trenton, New Jersey, was first put in service. The sewer from this wing was laid in a trench through red sandstone and shale and passed within fifty feet, horizontally, of the three deep wells which furnished the water supply of the hospital. These wells were approximately 260 feet deep, with iron casings extending down a foot into the hard rock. Wells thus constructed would ordinarily be regarded as being safe from pollution.

On account of a typhoid fever epidemic which had visited the hospital earlier in the summer, the only other available water supply, an open and polluted spring, had been cut off from the system and bacterial analyses of the well waters as they reached the buildings were frequently made. Twenty analyses of these waters made during the period, August 1st to August 17th, showed the absence of fermenting organisms, ten cubic centimeter quantities having been tested. *B. coli* was isolated from one ten cubic centimeter sample on August 17; from a one cubic centimeter sample on the 19th, and from three such samples on the 22nd. Thereafter it occurred in increasingly greater numbers.

*Read before the Laboratory Section of the American Public Health Association at Winnipeg, August, 1908.

Studies were made of the individual wells and *B. coli* were found regularly in 0.1 cubic centimeter in the water of that well nearest the new sewer, and in lesser numbers in the others.

Suspicion was naturally directed to that sewer. An investigation showed it to be poorly laid and in a leaky condition. Its use was discontinued on September 19th, and large quantities of bleaching powder were introduced with a stream of water. It was hoped by disinfecting the neighboring soil to repair some of the damage that had been done. A rather unusual opportunity was here offered for study. The wells were known to have been unpolluted up to August 1st, and polluted with sewage from August 1st to September 20th. After that time no new pollution was possible, the use of the sewer having been discontinued. These conditions were of so unique a character that occasion was taken to make a special study of the bacteria found in the waters and of the various methods employed for detecting pollution. Daily samples from each of the three wells were examined. Each sample was inoculated into dextrose broth, lactose bile and dextrose neutral red broth. The first medium was prepared according to the standard methods adopted by this section, the second according to Jackson's directions, and the third was like the first with the addition of neutral red.

RESULTS OF PRELIMINARY FERMENTATIONS:

For reasons which later appear the period covered by this detailed study will be divided into two periods of approximately thirty days each. The first from September 10 to October 12; the second from the latter date to November 9. During this entire period the results obtained on the dextrose neutral red broth were practically identical with those obtained on the standard dextrose broth. The former will not be considered further.

The results of the preliminary tests are tabulated below in the two periods mentioned and in a third period covering the entire time.

TABLE I

Results of Preliminary Fermentations and Isolation of B. Coli and Paracolon

Period	Volume tested c. c.	Number of tests Giving Gas in: Total	A: Dextrose only	B: Dextrose and Bile	C: Bile only	Number of Times B. coli found in: A	B	C	Total	Number of Times Paracolon found in: A	B	C	Total	Number of Times Colon Forms found in: A	B	C	Total
Sept. 10 to Oct. 12	10	109	21	56	3	2	43	3	48	14	11	0	25	16	54	3	73
	1	90	14	22	0	0	19	0	19	10	5	0	15	10	24	0	34
	Total	199	35	78	3	2	62	3	67	24	16	0	40	26	78	3	107
Oct. 12 to Nov. 9	10	88	34	14	3	0	7	1	8	30	9	2	41	30	16	3	49
	1	88	12	5	0	2	2	0	4	9	2	0	11	11	4	0	15
	Total	176	46	19	3	2	9	1	12	39	11	2	52	41	20	3	64
Sept. 10 to Nov. 9	10	197	55	70	6	2	50	4	56	44	20	2	66	46	70	6	122
	1	178	26	27	0	2	21	0	23	19	7	0	26	21	28	0	49
	Total	375	81	97	6	4	71	4	79	63	27	2	92	67	98	6	171

Note. – Dextrose results are recorded positive when gas appears within 48 hours, bile when 20% or more gas appears within 72 hours.

In this table, under column headed A, will be found results obtained on dextrose broth only, the corresponding bile test having been negative. Similarly under C the result was positive on bile and negative on dextrose. Under B are recorded results positive on both media. The division referring to *B. coli* includes those organisms which conform strictly to the tests laid down in the standard methods adopted by this section. The division referring to paracolon includes a group of forms which also conform strictly to those tests. The difference lies in the behavior of the two groups toward lactose. The former gives gas in lactose; the latter do not. It should be called to mind that gas formation in lactose broth is not an essential characteristic in the present standard method for the identification of B. coli. The third division includes both the groups and gives therefore the actual *B. coli* as at present defined.

Referring first to this third division, and taking the total period as given in the last line, we find that dextrose was fermented alone in 81 cases, and together with the parallel bile test in 97 cases,—a total of 178 times. Similarly bile was fermented 97, plus 6, or 103 times. Colon forms were isolated altogether in 171 cases. There were 178 positive preliminary tests in dextrose and 103 in bile, an apparent advantage in favor of the dextrose broth as a presumptive test. This advantage is seen to be still more striking if we consider only the 1 c.c. samples of this same period. Colon forms were isolated altogether 49 times. There were 53 positive preliminary tests in dextrose and only 27 in bile. Taking the period, October 12 to November 9, of all the samples tested, 65 fermented dextrose, 22 fermented bile, and 64 gave colon forms. In the same period of the 1 c.c. samples, 17 fermented dextrose, 5 fermented bile, and 15 gave colon forms. To better point out this rather unusual result these figures are tabulated by themselves, avoiding

the confusion of the larger table, the total colon forms being given in the last column.

TABLE II.

Relation of preliminary fermentation tests on dextrose broth and lactose bile to the final isolation of colon forms

Period	Volume tested c.c.	Number of Positive Fermentations in		Number of Positive Tests for		
		Dextrose	Bile	B. Coli	Para Colon	Colon Forms
Sept. 10 to	10	77	59	48	25	73
Oct. 12	1	36	22	19	15	34
	Total	113	81	67	40	107
Oct. 12 to	10	48	17	8	41	49
Nov. 9	1	17	5	4	11	15
	Total	65	22	12	52	64
Sept. 10 to	10	125	76	56	66	122
Nov. 9	1	53	27	23	26	49
	Total	178	103	79	92	171

Earlier in this work the fact was noted that the dextrose broth was giving much higher results in preliminary tests than the bile. This was to be expected, but it soon appeared that the dextrose results were in very close agreement with the final complete results, while the bile was very low as has been indicated. It was noted at the same time that the organisms fermenting the bile always gave strong red colonies on litmus lactose agar, while those fermenting dextrose frequently gave colonies which were red but not so strongly acid. At the beginning of the period covered by the above table, therefore, all cultures from dextrose fermentations were fished into ordinary lactose broth and into dextrose bile. As had been anticipated, those cultures which gave feeble acid production did not give gas in the lactose broth, but did ferment dextrose bile vigorously. Apparently there was present in these waters a distinct strain of organism which agrees with *B. coli* as ordinarily understood. It forms acid, but little or no gas in lactose. From that time on, then, these two types were distinguished. Tables I and II show the reason for the poor bile results. A large proportion of

these are typical forms, which, for want of a better name, are here called *paracolon*, were being dealt with. They did not ferment lactose and hence were lost by the lactose bile medium. It is interesting to note that the bile itself had no inhibiting effect upon them whatever in the dextrose bile medium.

An interesting point also is the relative abundance of the two types. To bring out the point the time has been divided into two periods in the tables. During the first period pollution was at a maximum, and during the second it was slowly disappearing. In the one case the lactose fermenting *coli* outnumbered the *paracoli* in a ratio of 1.7 to 1.0. In the other the ratio was over 4 to 1 in the other direction. That is to say, during the gradual improvement of the well waters the typical *coli* decreased at a much more rapid rate than did the *paracoli*. Toward the end of the study *paracoli* persisted for a considerable period after the typical forms had disappeared.

STUDY OF THE PARACOLON FORMS:

It was deemed highly desirable to obtain as complete knowledge as possible of this important group of organisms. Accordingly special studies were made upon it during this investigation.

Records were kept of the appearance of each litmus lactose agar plate from which colonies were fished. The amount of acid produced by the organism could be roughly indicated by the color given to the plates, recorded as red, pink, or no change. A total of 198 *paracolon* colonies were fished from an equal number of plates. The recorded color of these plates is given in the following table, divided as usual into two periods. During the same period 160 colonies were fished which proved to be typical *B. coli*. The recorded color of these plates was red in all cases.

A distinct change in the acid producing powers of these organisms is noticeable in this table. This seems to be directly associated with the more rapid decrease of the acid forming *coli* alluded to above. The tendency in both cases is to eliminate most rapidly those forms which most readily acidify lactose.

TABLE III.

Acidity produced by Paracolon as indicated by change of color in Litmus Lactose Agar

Period	Number of plates.			
	Total	Turning Red %	Turning Pink %	No change %
Sept. 10 to Oct. 12	104	29.8	52.8	17.3
Oct. 12 to Nov. 9	94	19.1	61.7	19.1

The evidence seems to be very definite here that those forms which have lived longest in the soil, or are farthest away from the initial sources of pollution are least able to ferment lactose. They produce acid less vigorously than the normal forms and form little or no gas. As to whether these forms represent degenerate individuals or constitute a distinct and more resistent strain remains to be shown.

Fifty strains were selected at random from the daily plates and subjected to a detailed study. They were first inoculated with lactose broth and dextrose bile media. Very feeble gas production was noted in lactose broth in a few cases. As a rule there was none. Dextrose bile was fermented vigorously, showing as has already been pointed out, that these forms are not excluded by the bile. After being on artificial media for a few weeks 70% of these cultures developed lactose-fermenting powers. This, however, was never vigorous as in normal *coli*. Their action upon saccharose was also tested. About half of them formed gas in that sugar. Or

the basis of their fermentations of lactose and saccharose the fifty strains were divided into four groups and further studies were made upon them. It became apparent that these four groups possessed several correlated properties in increasing or decreasing magnitudes, and further, that the whole division considered in respect to these characteristics lay intermediate between typical *B. coli* and *B. cloacae*. For the purpose of comparison 19 strains of *B. cloacae* were isolated from the same waters, the organism being quite abundant at that time. In the following table are shown the four groups of *paracoli*, selected in reference to their sugar fermenting powers, with a column of *B. coli* on one side and *B. cloacae* on the other. Numbers refer to per cent. of positive tests. Obviously no statistical value attaches to these results obtained on so few numbers, but the intermediate character of the group as a whole and a decided correlation of certain characteristics is distinctly indicated.

TABLE IV

Table showing the intermediate position of the four paracolon groups between *B. coli* and *B cloacae* and correlation between certain characteristics

Test	Per cent of Total Giving Positive Tests.					
	B.coli	Paracolon groups				B. Cloacae
		1	2	3	4	
Fermenting Dextrose	100	100	100	100	100	100
Fermenting Lactose	100	100	100	0	0	16
Fermenting Saccharose	?	0	100	0	100	100
Lactose strongly acid	100	67	44	29	20	0
Gelatin liquefied	0	0	14	14	60	100

In general these organisms would pass the ordinary tests for *B. coli*, and in fact they were selected on the basis of the standard tests for that organism. The liquefaction of gelatin noted occurred always between 14 and 28 days. Forms which liquefied more rapidly were classed as *B. cloacae*. The

distinction is obviously an arbitrary one, but was maintained according to present practice. On gelatin the growth was less luxuriant than usual, at times translucent. In milk acid production was less than normal. Coagulation generally occurred only after heating. Nitrate was reduced vigorously and indol produced rather weakly.

The gradual increase in the relative numbers of these atypical forms has been alluded to, as has the fact that they became relatively less active in acidifying lactose. It can be stated further that in all their characteristics they showed a definite progressive change during the period of the investigation. At first they were quite overlooked. Attention having been called to them through the low bile results they were later searched for, and identified on various platings by their slightly feebler powers of acid production in lactose. Identification at this time was quite difficult. Later, plates with pink colonies occurred more frequently. At the close of the study many plates were obtained in which no red colonies were found.

Upon fishing colonies which appeared to be otherwise typical, however, this organism was regularly isolated. The intermediate and gradually progressive characters of this organism appear to us to be of great significance.

In this same connection also, but possibly entirely independent of it, it should be stated that the appearance of *B. cloacae* was more frequent towards the end of the work and that after all other sewage species had practically disappeared, forms of proteus were frequently found.

Thus the change in characters from non-liquefying, lactose fermenting coli to liquefying non-lactose fermenting proteus was continuous and complete.

CONCLUSIONS.

We believe the results of this investigation have a greater importance than their mere scientific interest. According

to accepted standards of interpretation the pollution of these wells ceased with the disappearance of typical *B. coli.* But long after that point was reached other types presisted which were connected with the typical forms by a gradual and perfect transition. The arbitrary character of our accepted standards, necessary as it is in practice, appears to disadvantage in a case like the present one. For certain classes of work, such as the quantitative study of polluted rivers, the control of filtration processes, and legal work, a hard and fast definition of *B. coli* is needed. When we expect to find pollution we may measure it in this way better than in any other . *On the other hand, where it is desired to detect pollution, if any exists, however slight, where the least indication of pollution at present may mean serious consequences in the future; the most sensitive tests we have and the broadest possible interpretations are desirable.* In the present instance the source of pollution was known and had been dealt with. The actual amount of pollution was not serious. In fact, by excluding the one well and avoiding extra heavy drafts in the other two, and by discontinuing pumping entirely after rainstorms, this anxious period was safely tided over. But if the source of pollution had been unknown and the continued use of the water had depended upon the bacteriologist's report, great harm might have been done by a too rigid adherence to the accepted definition.

One further point of immediate importance is this: The standard methods adopted by this section allow the use of either dextrose or lactose in preliminary tests. In the confirmatory tests, however, the production of gas in lactose broth is not made an essential feature. This inconsistency should be remedied. In the present case two independent workers, both following conscientiously the present standard methods, would have come to opposite conclusions regarding the presence of *B. coli,* in 50% of the samples tested had one worked with dextrose and the other with lactose broth. Either

the definition of *B. coli* should be made to include fermentation with gas production in lactose broth, or the latter should not be used in preliminary tests. Lactose was introduced in place of dextrose, which was long the standard, to cut out certain organisms such as cloacae. The process of cutting out seems to be too severe, and in our opinion, where the fullest possible knowledge of conditions is desired, the use of dextrose broth in preliminary tests is to be recommended. For presumptive and comparative tests in such routine work, as the systematic control of filters or the regular examination of water supplies, lactose may still find useful application.

Since the original communication additional attention has been given to the organisms referred to as paracolon forms.

In a fairly large series of fecal examinations comprising about 100 examinations, made at the New Jersey State Hospital in connection with typhoid bacillus carriers, the occurrence of organisms answering to the description given above has been particularly searched for. That these are undoubtedly fecal in origin is shown by the fact that there was scarcely an examination in which forms could not be found which corresponded exactly to the various characteristics of the paracoli found in the water examinations if properly searched for. On the Drigalski-Conradi medium used in the series the initial colonies at times somewhat resembled those of the *B. typhosus*, while others would simply be regarded as a typical colon colonies unless further investigated.

It is doubtless this indefinite character of the initial growth of these organisms on lactose media even when grown directly from feces which has led largely to their neglect as indicators of fecal pollution in the interpretation of results of bacteriological water analysis.

AESCULIN BILE SALT MEDIA FOR WATER ANALYSIS*

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The considerable diversity of "presumptive" tests used in England and America for *B. coli* and other excretal organisms renders an apology almost necessary when introducing yet another test to the attention of laboratory workers. Such a presumptive test (and by this term we mean a simple test which will indicate in the majority of cases whether a water contains excretal organisms or not) largely used in American laboratories is the production of gas in a fermentation tube containing dextrose broth, with a gas formula of $H:CO_2=2:1$.

In English laboratories the bile salt broth of McConkey and Hill[1] or the modification of this medium with Neutral Red as suggested by Grünbaum & Hume[2] is more commonly employed. Phenol broth, lactose litmus agar, and other media have also been used by various workers.

Several investigators[3] have pointed out the limitations of these tests; thus in the case of the fermentation of dextrose,—that the amount of gas, and the percentage of CO_2 are subject to variation, even with pure cultures of *B. coli*, and that *B. coli* is frequently present in fermentation tubes in which the amount of gas was less than 10 per cent. after 48 hours' incubation at 37° C.

Irons[4] in an investigation comparing the results obtained with the dextrose fermentation tube and with neutral red

*Read before the Laboratory Section of the American Public Health Association at Winnipeg, August, 1908.

broth found in 285 determinations 35 per cent. of positive results with the neutral red method. Prescott and Winslow[5] in a paper on the relative value of dextrose broth, phenol broth and lactose bile as enrichment media for the isolation of *B. coli* examined 176 samples of water from various sources. From the data they obtained they considered the bile medium inferior to dextrose broth as an enrichment medium in the process for the complete isolation of *B. coli*, but as a *presumptive* test, when the full working out of *B. coli* was impossible, the bile medium offered distinct advantages. Thus they sum up their experimental facts as follows:

"If the proportion of cases in which *B. coli* was actually isolated (70 out of these 176 samples) be taken as 100, the percentage of complete, positive results, using bile for preliminary enrichment was 91. If the dextrose broth fermentation test alone had been considered positive 120 "presumptive" tests would have been obtained, or 171 per cent. of the real number. On the other hand, the positive presumptive tests in bile, considering all gas formation as positive, would have given 78 positive results, or 111 per cent., only slightly in excess of the true value. As a presumptive test, the lactose-bile medium seems to yield a fair approximation to the truth, being far superior in this respect to dextrose broth.

Savage[6] strongly recommends the use of neutral red bile salt broth, the bile salt checking the growth of organisms other than *B. coli*, and the reduction changes in the neutral red serving as an indicating agent.

In the examination of water for *B. coli* none of these "presumptive" tests are reliable[7] in themselves, either to indicate that a water is good or bad, or that it contains or is free from *B. coli*. These preliminary tests have a great value in that they *indicate* the *probable* numerical presence of *B. coli*, and so save the labor of plating *all* the different dilu-

tions made. That is their object, and as such they are of extreme value, but they are not sufficiently reliable to take the place of the isolation and numerical determination of *B. coli* itself." The American Standard Committee come to similar conclusions.

The experience of the investigators mentioned above have been fully borne out by our own. During the last few years one of us has had occasion to analyse several hundred samples of water from many sources, the enrichment medium usually employed being dextrose broth in fermentation tubes. Latterly, however, the neutral red bile salt medium has been used with fairly satisfactory results.

Recently, we have had occasion to make a large number of analyses of the Ottawa River water, and as *B. coli* or its varieties was constantly present in amounts of 5 c. c. or less, it was necessary to find out the exact number of this organism, and for this purpose we employed the neutral-red-bile-salt-lactose agar of Grünbaum & Hume. The counting and isolation of *B. coli* from this medium gave us fair results, but even with considerable practice, we were at times unable to determine from the appearance of the colony whether it was that of *B. coli* or some other organism which produced red colonies with the surrounding medium red; and on this account we determined to use aesculin instead of neutral red.

Aesculin is a glucoside and undergoes a hydrolitic fermentation when *B. coli* and some other organisms are grown in a medium containing this sugar. The reaction, as nearly as one can express by this means a bacterial reaction, is probably as follows:

$$C_{15}\ H_{16}\ O_9 + H_2O = C_6\ H_{12}\ O_6 + C_9\ H_6\ O_4$$

Aesculin + water = Sugar + Aesculetin

The aesculetin then combines with the iron salt (Iron citrate) used in the medium to form a dark brown salt.

The reaction only takes place in sugar free media. Col-

onies of *B. coli* in media containing aesculin, are black with a black halo around them, and they are thus very easily seen, and can be readily counted against a white background.

It is true that other organisms besides *B. coli* give the reaction, notably *B. lactis aerogenes*, lactose fermenting yeasts, and some moulds, but the last two may be disregarded, as they are seldom found in water, and the appearance of their colonies is characteristic. *B. lactis aerogenes* may be regarded as an excretal form, and hence it is of some benefit to be able to recognize its presence, and with very little practice the appearance of the colonies of this organism on the aesculin medium may be readily noted, as the colonies are larger, moister, and more raised than those of *B. coli*. Some forty species or varieties* of bacteria and yeasts have been grown in media containing aesculin with negative results.

The preparation of aesculin media is easy, and different lots are very uniform in composition. Our usual method of preparing is to first weigh out,—

1 or 2 per cent. Witte's peptone,
.5 " " sodium taurocholate (commercial),
.1 " " aesculin,
.05 " iron citrate,
100 c. c. Tap-water.

After steaming from 15 to 30 minutes the medium is filtered and filled into test tubes. For aesculin agar 1.5 per cent. of agar is used, and after dissolving the agar in part of the water the remaining ingredients are added, brought to the boil and then filtered, or else the medium is cooled for the addition of white of egg or albumen, again brought to the boil, and then filtered and tubed.

*B. fluorescens; B. fluor. liquefaciens; B. prodigiosus; B. lactis viscosus; Slimy milk bacteria, 3 species; B. butyricus; B. Zopfii; Proteus vulgaris; B. mesentericus; B. mycoides; 5 species lactic acid bacteria; B. cloacae, one culture from Jordan and one from Johns Hopkins University; etc., etc.

The tubes may be either sterilized in the steam sterilizer on three successive days, or autoclaved for 15 minutes at 15 lbs. pressure.

We advise using bile-salt-aesculin-broth and aesculin agar for the routine examination of water, as the former acts as an enrichment method, and the latter indicates the number of colonies of *B. coli* present per c. c. in the small quantities of water used in pouring the plates. The method usually employed is as follows: We add 1 and 5 c. c. of water to two test tubes of aesculin bile salt broth, and place in sterilized Petri dishes one, two, three or five cubic centimetres of water, respectively, and then pour into each plate melted aesculin bile salt agar, from 8 to 16 c. c., depending on the amount of water used. After using sufficient of the sample for other plates, 10 c. c. of four times strength aesculin bile broth is added to the sample bottle, and all tubes, plates, etc., are incubated at 37.5°-40°C. For waters in which the colon bacillus is present in quantities of 5 c. c. or less, the aesculin bile salt agar gives very reliable results. If black colonies are present on the plates, they may be subcultured in 24 hours, and even the presence of the black colony furnishes presumptive evidence, as in the analysis of more than 60 samples of surface waters we have invariably found that the black colony on being subcultured presented all the features of an "excretal *B. coli*" or *B. lactis aerogenes*. When using aesculin bile salt broth, if a positive reaction takes place the medium turns black, and we consider this reaction a better presumptive test for *B. coli* than the red colonies in neutral red bile salt lactose agar, or gas and acid in dextrose broth, as from the result of 60 tests in which we obtained a black coloration in aesculin bile salt broth, we secured the same number of (60) positive tests of *B. coli*.

The disadvantages of both the above methods is the comparatively small amount of water that can be used; larger plates and larger tubes allow 10 c. c. samples to be used, but

it is more satisfactory to use the remainder of the water in the sample bottle. Our sample bottles are glass stoppered, hold about 110-120 c. c. of water, after taking out as much water as is necessary for plates and tubes, 5 to 10 c. c. of four times strength aesculin bile salt broth is poured in, the stopper replaced, and the bottle incubated at 37°-40°C. for 24 hours. If the contents of the bottle turn black we have found that *B. coli* is invariably present, for in the large number of tests by plating from the discolored samples and subculturing, which we have made, we have always succeeded in isolating a typical *B. coli.*

Following the method we have employed we obtain from aesculin agar the *number* of *B. coli* in 5 c. c. of the sample of water, and from our aesculin broth tubes, indication of the *presence* of *B. coli* in 2, 3 and 5 c. c., respectively, and should *B. coli* be absent from all of these, we may safely assume that it is absent from 16 c. c. of the sample water. Our enrichment medium in the sample bottle will inform us if *B. coli* is present or absent in 100 c.c. Absence of black colonies on the plates, and no black discoloration in the tubes, but blackening in the sample bottle, will give us the information that *B. coli* is absent in 16 c. c., but present in 100 c. c. These amounts may be easily varied to suit other requirements.

In conclusion, we may again assert that in the analysis of 60 samples of water we have found the aesculin bile salt test has been correct in 100 per cent. of our samples, or in other words, all samples which give a positive reaction—as indicated by a black color in aesculin bile salt broth—contain "excretal *B. coli,*" adopting the definition of Savage[5], or are "flaginac," using the basis of classification suggested by Houston[8].

We have recently found out that the bile salt restrains the growth of some varieties of the coli group. These varieties do not show any well-marked deviation from the

ordinary morphological or cultural characters of *B. coli*, but they are influenced to a certain degree by the presence of the bile salt in the medium, and do not grow quickly or fully when this salt is present in the quantity suggested by McConkey. On this account, we have recently started a number of experiments, comparing aesculin without bile salt, with aesculin with bile salt. Whilst the number of these experiments may not be sufficient to enable us to definitely decide which is the better method, yet the results seem to show that bile salt is not absolutely necessary, and that aesculin bile broth is inferior to the aesculin broth as an *enrichment* medium for *B. coli*, but in all cases, the black discoloration of the aesculin method has been caused by typical *B. coli*.

By positive test we mean that the organism is motile and resembles B. coli in size, typical appearance on gelatine slope, no liquefaction of gelatine, acid production and coagulation in litmus milk, and permanency of this acid. Production of acid and gas in dextrose and lactose media. Canary yellow fluorescence in neutral red media. Production of Indol in five days in peptone water.

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AESCULIN BILE SALT MEDIA FOR MILK ANALYSIS. *

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The routine bacteriological examination of milk in health laboratories usually consists of plating samples in beef peptone gelatine and beef peptone agar, at 20° C. and 37° C., respectively. The plates are counted and the total number of bacteria computed per cubic centimeter of the sample. The species of bacteria present are seldom noted, owing to the large amount of work involved in sub-culturing the various colonies.

The total number of bacteria found in any given sample of milk may or may not give indications of dirty cows and unsanitary utensils and stables, for the milk may have come from clean animals and sanitary stables, but may have been kept in a warm place, which would give a high count. Hence the advisability of introducing a simple method of analysis, whereby the bacteria associated with dirt, manure, etc., may be easily and accurately estimated. Such a method is furnished by the use of aesculin bile salt agar, which will permit of an accurate determination of the number of *B. coli* and *B. aerogenes* present, and thus give information regarding the amount of filth and particularly manure in the sample. One of us in a previous investigation* has shown that *B. aerogenes* is as frequently present in cow manure as *B. coli*, and also that both organisms are

*Read before the Laboratory Section of the American Public Health Association at Winnipeg, August, 1908.

present in large numbers on the bodies of various species of flies.

We have already pointed out in the paper, "Aesculin Bile Salt Media for Water Analysis," that aesculin in the presence of iron gives black colonies with *B. coli* and *B. aerogenes*, and that both organisms may be counted separately on the plates, on account of the different characters of their colonies.

For routine examination of samples of milk we have usually employed dilutions of 1 in 100 and 1 in 500. For poor milk, however, a higher dilution may be necessary. The diluted milk and the aesculin bile salt agar are mixed together in the plate, and after these have thoroughly set, they are placed in the incubator at 37° C. Counts are made at the end of 24 hours. The black colonies may be readily counted with a white background and the number of *B. coli* and *B. aerogenes* computed, per c. c. More striking results may be obtained by leaving the plates somewhat longer in the incubator, particularly if one wishes to separate *B. coli* from *B. lactis aerogenes*. We have used this method for some 30 samples of milk, with encouraging results. It has always been quite easy to distinguish the coli colonies on account of their blackness. Brown colonies are frequently found on the plates. These, on examination, have proved to be forms which liquefy gelatine. The difference in color between the black and the brown is quite distinct. We cannot yet say if the brown colony has any significance, from a hygienic standpoint. It is certain that not all liquefying colonies will give the brown discoloration, but the medium would be even more useful and valuable if we could ascertain both the number of colonies of the coli group and the number of colonies in the liquefying groups, from aesculin bile salt agar plates.

At this stage of our work, we can hardly suggest a numerical standard for *B. coli*, but we may suggest that if the

100,000 bacteria per c. c. standard is in use, the number of *B. coli* and *B. aerogenes* should not exceed 1000 per c. c., or 1 per cent. Possibly a different standard would be necessary for certified milk, or where the standard was 10,000 bacteria per c. c. These points can be better determined after other laboratory workers have given this method a trial. We are of the opinion—as a result of our analyses—that compared with ordinary beef peptone agar, aesculin bile salt agar gives a better appreciation of the sanitary condition of milk samples, and gives such results in 24 hours. If in routine examination of milk, only one set of plates was made from each sample, we should prefer to use aesculin bile salt agar, as it would give us a better idea of the sanitary condition of the cows, stables, and milking. The details in connection with the preparation of aesculin bile salt agar are given in the paper already referred to, and the results of a number of examinations of milk samples by this method, compared with others, have been submitted in detail to the Milk Committee of the American Public Health Association.

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THE RELATIVE PROPORTION OF BACTERIA IN TOP MILK (CREAM LAYER) AND BOTTOM MILK (SKIM MILK), AND ITS BEARING ON INFANT-FEEDING.[1]

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ABSTRACT

In the course of a study on tubercle bacilli in market milk[2], and of a later study of the best procedure for their detection in milk it was noticed that when guinea pigs were inoculated with the cream a very much higher percentage died from acute infections than when the sediment was used. The inference was natural that the cream contained more bacteria than the bottom milk or sediment.

A few preliminary examinations having shown this supposition to be correct, a study was begun as to the number of bacteria in the whole milk, the bottom milk or sediment, and the cream of both that collected by gravity and by centrifugation.

The relative number of bacteria in top milk and bottom milk is of great importance in the modification of milk for infant feeding. Top milk sometimes contains from 10 to 500 times as many bacteria per cubic centimeter as the mixed milk.

[1]Abstract of paper read before the Laboratory Section of the American Public Health Association at Winnipeg, August 25, 1908.

[2]Anderson, John F.: The frequency of tubercle bacilli in the market milk of the city of Washington, D. C. Bull. No. 41, Hyg. Lab., U. S. Pub. Health & Mar. Hosp. Serv., Wash., 1908, p. 163.

The preponderance of bacteria in top milk may explain why infants sometimes do not thrive on modified milk made from top milk.

As infection depends to some extent on the number of organisms introduced into the body, top milk, on account of its higher bacterial content, may sometimes be more harmful than skim milk.

In 30 samples of milk examined the average number of bacteria in gravity raised cream was 69,211,000, and in the sediment layer 4,360,000 bacteria per cubic centimeter.

In 26 samples of milk the average number of bacteria in gravity and centrifugally raised cream, in the sediment layer, and in the mixed milk was

Gravity		Centrifugalized.		Whole milk
Cream layer	Sediment layer	Cream layer	Sediment layer	
68,690,000	4,840,000	96,690,000	18,840,000	14,388,000

In six samples of milk the average relative number of bacteria in the gravity cream was 15,416,000, skim milk 2,050,000, in the sediment layer 1,405,000, and in the whole milk 2,708,000.

In seven samples of milk the average relative number of bacteria in the centrifugally raised cream was 4,500,000, in the sediment layer 725,900, in the skim milk 119,700, and in the whole milk 619,800.

One sample of milk contained 500 times as many bacteria per cubic centimeter in the cream as in the bottom milk.

When milk is centrifugalized the great mass of bacteria goes up with the cream; a lesser number is carried down in the sediment. The skim milk contains many times less

numbers of bacteria per cubic centimeter than the cream or sediment layers.

Centrifugally-raised cream contains more bacteria per cubic centimeter than the gravity-raised cream from the same milk.

SOME FREAK RESULTS FROM ANIMAL INOCULATIONS.*

By B. L. ARMS, M. D., Bacteriologist, Boston Board of Health Laboratory

It has occurred to me that some of the results out of the usual course might be of interest, consequently a few of our freak results are presented.

All routine animal inoculations are made in duplicate, thereby reducing the chance of failure from loss of the animal inoculated.

Guinea pigs have given perfect satisfaction for rabies, tuberculosis, glanders and K. L. virulence tests which comprise most of our animal work and consequently are used by us almost exclusively, the number under observation at any one time varying from 80 to 200 according to the work on hand.

For rabies inoculations a small jeweler's screw-driver is used, boring through skin and calvarium and the material (an emulsion of hippocampus major, cerebellum and spinal cord ground up in sterile water) is injected subdurally.

The T. B. inoculations are made subcutaneously, and those for glanders intraperitoneally. For the latter we add about 3 c. c. of sterile water to the swabs from the lesions as sent in by the veterinarians, one pig receiving 1 c. c., the other .5 c. c., except in cases showing microscopically large numbers of bacteria, in which case 1-2 and 1-4 c. c. is used, the pigs being referred to as the 1 c. c. and the .5 c. c. pig.

*Read before the Laboratory Section of the American Public Health Association at Winnipeg, August, 1908.

When making the suspension for glanders inoculations a plant is made on potato, then a smear is made and finding noted on the card sent in and which is filed away with the animal cards when test is finished.

Tuberculosis

November 16, 1906, two pigs were inoculated subcutaneously with pleuritic fluid.

Six weeks later one pig was autopsied, the inguinal glands and spleen presenting the typical tubercular picture and stained smears showed the typical organisms. The other pig showed no enlargement of the glands and was used for an inoculation on a positive rabies case, which will be mentioned later. June 29, 1907, or seven months after inoculation, the pig died and on autopsy the lungs, spleen, liver, colon, adrenals, bladder and one axillary gland were microscopically typical, while the organisms were demonstrated in smears from lungs and spleen.

Rabies.

The head of a dog was received December 22, 1906, examination of sections the following day showed a small number of Negri bodies in the hippocampus major. Two pigs inoculated the day the dog was received died on the following day.

December 24th two more pigs were inoculated with an equal amount of the emulsion; one of these developed a typical paralysis on the 11th day, dying the following day. The other pig showed no symptoms and was autopsied 13 months later, examination of brain negative.

December 29, 1906, another dog's head was examined, many Negri bodies being found in smears and sections of hippocampus major and in sections of cerebellum. Two pigs were inoculated the day the dog was received, one

dying that night, the other being the T. B. pig previously mentioned. This pig showed no symptoms of rabies, although living six months, and the examination of the brain was negative.

December 30th another pig was inoculated with the emulsion from this dog's brain, and this pig was kept under observation for 13 months, when no symptoms having developed, chloroform was given and careful examination of many sections of both hippocampus major and cerebellum gave a negative result.

These are the only instances in which inoculation with material from a case showing Negri bodies has failed to give a positive result in pigs inoculated.

April 1, 1907, we received the head of a dog. Examination of smears and sections failed to reveal Negri bodies, although the gasserian ganglia showed marked proliferation of the endothelial cells of the capsules of the nerve cells. The case was reported as suspicious, diagnosis awaiting result of animal inoculations.

April 2, 1907, two pigs were inoculated, subdurally drawing about .5 c. c. of the emulsion into a hypodermic syringe and putting half of this into each pig. April 24th, or 22 days after inoculation, one pig developed a typical paralysis and was autopsied. Smears from hippocampus major showed many Negri bodies. The other pig developed no symptoms until November 28, 1907, when he showed a slight paralysis. The following day or 242 days after inoculation he was autopsied and smears and sections from the horn and cerebellum showed great numbers of Negri bodies of varying sizes.

Glanders

February 12, 1908, two pigs were inoculated with the material from an ulcer. Stained smears from the pus showed many cocci and suspicious bacilli.

Five days later a small tumor was noticed at site of inoculation. This remained, but there was no slough; inguinal glands became enlarged, scrotum became edematous, but this later subsided. Twenty-five days after inoculation the pig was chloroformed, and on autopsy there was, at the site of inoculation, a mass of caseous pus, inguinal glands were caseous and there were caseous nodules in liver and spleen. Smears from site of inoculation showed typical organisms.

Cultures were made from heart's blood, liver, spleen and site of inoculation. That from the heart's blood was negative, the others positive.

Two pigs inoculated, one with 1 c. c., the other with .5 c. c. of aqueous suspension from these cultures developed characteristic Strauss reaction in 48 hours.

May 5, 1908, two pigs inoculated with a suspension of a nasal discharge. Five days later the .5 c. c. pig showed the characteristic Strauss reaction, and on autopsy the following day typical organisms were found in smears, and typical cultures developed.

On the 1 c. c. pig a tumor was noted at site of inoculation on the 12th, seven days after inoculation. A typical Strauss reaction was present at end of 14 days, when autopsy was made, disclosing a large abscess in the omentum from which organisms were recovered typical both microscopically and culturally. No typical organisms from testes or inoculation site, although cultures were made as well as microscopic examination.

May 7, 1908, two pigs inoculated with a suspension of a seropurulent nasal discharge. On both a tumor was noticed at site of inoculation four days later. The 1 c. c. pig showed a slight Strauss reaction on the 20th, becoming complete, and autopsy was made May 23, 1908. Organisms were microscopically and culturally typical; .5 c. c. pig developed a slight Strauss reaction on the 2nd of June, but

owing to stress of work, autopsy was not made until the 12th with the following findings: Abscess in right groin, right testis intraperitoneal and converted into an abscess, and there were enlargements on both fore ankles and on the left hind ankle. Typical organisms were obtained from both abscesses and from bud on left hind ankle.

May 9, 1908, two pigs inoculated with a suspension from a nasal discharge. On the 15th note was made of a tumor at site of inoculation on the 1 c. c. pig, Strauss reaction present May 18th, when autopsy was made—organisms typical. Tumor was noted on .5 c. c. pig at site of inoculation May 25th, autopsied the following day, finding a tumor in omentum and another in right groin. Microscopical examination negative, typical cultures from both tumors.

May 27, 1908, two pigs were inoculated with material coming from an abscess on the shoulder. The 1 c. c. pig developed typical Strauss reaction in seven days; .5 c. c. pig presented a tumor at site of inoculation, which was noted on the 6th of June, and was autopsied 30 days after inoculation. Tumor at inoculation site was only lesion present. Cultures from this were typical.

June 12, 1908, two pigs were inoculated with material from an abscess on the shoulder. Eight days later more material from the same source was put into the pigs, and at this time a very small tumor was noted on .5 c. c. pig at inoculation site. This sloughed on the 17th day, and a culture was made with negative result. Pig died 25 days after inoculation, and autopsy was made the next day with the following finding: tumor at inoculation site, right testis converted into an abscess, although there was no process just under the tunica vaginalis; just under the skin on left testis, but outside the tunic, there was pus; there were tumors on each extremity and the spleen and liver both showed lesions. Typical organisms microscopically

from two "farcy buds"; culturally from three "farcy buds," and from spleen and heart's blood.

Aside from these cases we have several times failed to get a reaction in the pigs when the potato culture from the swabs showed typical colonies and these injected into pigs proved to be *B. mallei.*

Conclusions

1. All pigs inoculated for T. B. should be autopsied.
2. All negative rabies pigs should be kept under observation for twelve months.
3. All negative glanders pigs should be kept under observation for at least four weeks.
4. All pigs inoculated for glanders dying after 48 hours should be autopsied.
5. Any inoculation may give a freak result, consequently the unusual must be borne in mind.

INVESTIGATION TO FIND THE MOST ECONOMICAL RATIO OF PERMANGANATE TO FORMALDEHYDE FOR USE IN PRACTICAL PERMANGANATE-FORMALDEHYDE DISINFECTION*

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Problem: The permanganate-formaldehyde method of disinfection is becoming very widespread, especially in the smaller towns, villages, and in rural districts; because of its simplicity, absence of apparatus, etc.

Inquiries concerning the "best formula" for use in practice are constantly received; several formulæ have been advised by different authorities, and confusion has arisen. Hence a new method for determining the "best formula" was devised and is here described, with the results so far obtained.

Existing formulæ: The Bureau of Animal Industry recommended practically 8 parts permanganate to 10 parts formalin (40% solution of formaldehyde in water) claiming an evolution of about 50%.

Evans of Maine recommends practically a 4.15 to 10 formula, and McClintic (P. H. & M. H. S. Bull. No. 27), a 5 to 10 formula.

A recent report of an Austrian Government Commission recommends dilution of the formalin with water. McClintic sees no advantage in such dilution, but did not use the formula for mixing here recommended. As there was nothing to show that any of these formulæ were determined in a manner fully comparable with the actual use of the method in

*Read before the Laboratory Section of the American Public Health Association at Winnipeg, August, 1908.

practice, it was thought well to try the experiments on a working scale with formulæ developed by ourselves.

Experimental work: In collaboration, the writers first devised a small experimental apparatus, which was constructed on principles more likely to give "practical" conditions than those described, testing the evolution of gas from different mixtures, with loose crystals, and cakes, and with diluted formalin, as recommended by the Austrian Commission. The sixty or seventy results obtained showed many interesting points, but since they were repeated with a "full-charge" apparatus, built in our own shop, to our own designs, on a full size working scale, such as we believe has not yet been attempted elsewhere, further reference to these is not necessary. The reason for making these preliminary laboratory tests was that the large scale tests were relatively expensive and difficult; and the smaller scale tests could be made as "feelers" more easily, quickly and cheaply.

Difficulties and side problems: The reaction consists in the oxidation by the permanganate of part of the formaldehyde with the simultaneous reduction of permanganate, this reaction generating much heat, which evaporates the unattacked formaldehyde, together with the water of the formalin. Every change in the proportions in which the two are mixed, and some of the changes in the physical conditions existent at the time, affect the ratio of the amount of formaldehyde *destroyed,* to the amount *evolved.* The "maximum required result from the minimum necessary expenditure" is, of course, the ideal to be sought, i. e., such a ratio as will destroy the least formaldehyde, and evolve the most. Yet, if the maximum *percentage* evolution of formaldehyde be obtained, at a great expenditure of permanganate, the increased cost of the permanganate may offset the increased percentage of formaldehyde. Hence the relative costs of the two enter as an additional problem in determining the *optimum* formula. Finally, every change in the phy-

sical conditions of the experiment affects the results more or less—the surrounding temperature and temperature of the apparatus, the size of the permanganate crystals, their distribution in the container, the temperature of the formalin —all affect the results. Hence it became all the more essential to make full-charge tests under strictly average conditions.

Formaldehyde Full-Charge Tester

The apparatus consists mainly of two galvanized iron cylindrical tanks, an outer one to contain the water, an inner inverted tank or bell, inside of which was suspended the reaction vessel, and to which was connected the absorption jars and suction pump.

Description of Apparatus

The outer tank is 27½ inches in diameter and 42 inches high and was fitted with drain cock at the bottom, otherwise plain. Its capacity is about 10 liters to the vertical inch.

The inner tank or bell is 20 inches in diameter and 33½ inches high, and is suspended from the top of the outer one by iron hooks with its lower edge at the height of 23 inches above the bottom of the outer tank. A row of small holes was made two inches from the bottom of the bell to secure absorption of the gas should it tend to be forced out under the edge. At one side of the top a combined air inlet and water trap was placed to let in air at ordinary pressure and to prevent the escape of gas during the violent reaction. The bell is stayed with wires so that it cannot tip over. At the other side of the top are two three-fourth-inch outlet tubes leading to the absorption jars. In the center a hole was made to admit the separatory funnel containing the formalin.

The absorption jars are one-quart Mason fruit jars, with three-fourth-inch inlet and outlet tubes soldered into the

covers. Four were used in one series, connected to the large vacuum pump, and three in the other, connected to the smaller pump. The water used for absorption was iced to increase absorption of the gas. The inlet tube in each jar was expanded and fluted at the lower end to secure more surface for absorption of the gas in the water. The depth of water over the mouth of the inlet tube was about two and one-half inches. Inasmuch as it was required to draw out and absorb a large quantity of gas in a very short time so as to keep the pressure from rising greatly, one of us (M. G. R.) designed and had the laboratory machinist make two suction pumps of large capacity which require comparatively little water to operate. Their combined capacity is about 25 gallons of air per minute, under the conditions existing in the apparatus. To secure as closely as possible actual conditions, the reaction vessel used was an ordinary 14-quart galvanized iron pail, such as would be available anywhere.

Procedure in Making a Test

The permanganate is weighed out into the reaction vessel (14-qt. pail) which is placed on the supports inside the bell. The latter is then hooked up above the outer tank which is filled with water to a depth of 28 inches, giving a water seal for the bell of three inches above the row of holes, and in case of gas coming out below the bell the water rises about three inches higher, giving five inches of effective absorption.

The trap is adjusted to about one inch of water. The jars are filled about two-thirds full with *ice* water and connected to the outlet tubes, and the pumps are connected to the last jars of the two series. The formalin is placed in the separatory funnel, ready for admission. All being in readiness, the pumps are started and the formalin allowed to flow into the reaction vessel. During the violent reaction which ensues (in 10-30 seconds usually), pressure is sometimes generated, which forces considerable gas out under the bell, but

this has as good an opportunity for absorption (in the water there present) as that going through the jars, which latter is so complete that not more than 1% is found in the two last jars combined.

After the violent reaction is over the pumps are slackened gradually and the traps opened to allow free access of air. At the end of one and one-half hours the apparatus is thoroughly washed down with a small hose into the tank, after which everything is taken apart, the jars emptied into the tank and the water in it thoroughly mixed and sampled.

The residue is also soaked out for about fifteen minutes; the water used measured and a portion saved. In these two samples the formaldehyde is determined by the iodine method; and, by calculation the total amounts found. That in the tank represents the portion evaporated and that in the washings from the reaction vessel the residual. By difference, the amount destroyed is found.

It is believed that the total experimental error in the use of the machine does not amount to over 2% of the amount evaporated, and this is no greater than the variations due to impurities in the permanganate or to variations in the strength of formalin used. The sources of error are:

1. Failure to secure total absorption. The absorption under the conditions was usually within 98-99% of possible, judging from all the available evidence.

2. The titration by the iodine method is not more reliable than within one part in 50, i. e., when a titration gave a result of 38% strength, it could be assumed that the actual strength lay between 37.5% and 39.5%.

3. No doubt, during very violent reactions, a slight loss occurred from gas escaping below edge of bell; but, of course, this occurred seldom to such an extent as to cause appreciable error.

Results Obtained

Summary of Mr. Roberts' results to date (Aug. 21st, 1908,):

1. The best formula for simple mixtures of permanganate and formalin (i. e. with no added water) is as follows:

(a) The *ratio* is 7 parts by weight permanganate to 10 parts by volume formalin. This gives a liberation of from 62 to 65% of the total formaldehyde, the rest being destroyed in the reaction except a small proportion remaining in the residue.

(b) The absolute quantities required to produce the evaporation of *the equivalent of the complete evaporation of* 10 *ounces of formalin* (40% solution of formaldehyde in water) is 11.2 ounces permanganate and 16 ounces formalin—i. e., a reduction of weight, bulk and expense of materials from the existing formula in use here (i. e., 16 ozs. permanganate to 20 ozs. formalin) of about 25%.

2. The best formula for mixtures of permanganate and formalin with *water added* in various proportions, is as follows. (Note—If the humidity is increased, the amount of formaldehyde required to accomplish the same bactericidal effects is greatly reduced. The ideal is enough humidity to saturate the atmosphere, which permits the use of the minimum amount of formaldehyde.)

(a) The *ratio* is permanganate 11, formalin 11, water 9; giving an output of 48% formaldehyde, and evaporation of the total available water.

(b) To secure the equivalent of the *complete evaporation* of five ounces of formalin which is probably all that is required *in the presence of a saturated* atmosphere (i. e., saturated by the simultaneous evaporation *from the mixture* of the added water as well as the water of the formalin solution) the formula is, permanganate, 11 oz.; formalin, 11 oz.; water, 9 oz. This is based upon formalin of the probable average commercial strength, i. e., 38 1-2% formaldehyde;

the permanganate used was approximately 99% pure. If either or both ingredients run appreciably lower in strength than these figures, as they frequently do, the deficiency may be allowed for by portionately increasing the absolute amounts. However, this formula has a margin of safety which takes care of the reasonable variation in good commercial products, i. e., of 2 to 4%. (Note—In buying formalin or permanganate it is well to specify the percentage purity and check the same on receipt of goods.) The percentage saved in bulk weight and expense over the existing formula is 39%. This is secured by virtue of the releasing of a large quantity of water, approximately one pint per thousand cubic feet, reducing the required formalin very greatly.

That this formula (11 ozs. permanganate, 11 ozs. formalin and 9 ozs. water) will yield sufficient gas to kill the ordinary pathogenic bacteria, *under the conditions of high humidity secured,* approximating the saturation point, is readily believed in view of the work showing the efficiency of much smaller amounts of formaldehyde gas under like conditions. But should anyone desire to attain a greater efficiency in any given case, as in the disinfection of rooms infected with anthrax, tuberculosis, or *B. subtilis,* the same *relative* formula may be used, increasing the actual number of ounces proportionately in each case.

It is to be noted that ordinary formalin contains from 6% to 16% of methyl alcohol, the manufacturers stating that this is essential to prevent polymerization—the winter-made formalin containing the larger percentage, the summer-made, the smaller. The above formulæ were worked out on a basis allowing for the presence of the alcohol.

NOTE—Owing to the resignation of Mr. Roberts from the staff, on the completion of his work, certain check experiments contemplated were postponed. His successor, Mr. H. A. Whittaker, Chemist in Charge of Water and Sewage Laboratory, undertook these and reports as follows:

"On the request of Dr. H. W. Hill the chemical work on the foregoing report was duplicated by myself with the same apparatus used by the authors. Similar results were obtained in this second set of experiments, verifying the ratio obtained by the originators as giving the maximum results. Other ratios were tested with the same apparatus and found to generate less formaldehyde gas. The possible sources and probable ranges of error were carefully observed and were found to be as recorded by the authors in their report." H. A. WHITTAKER.

Explanatory Note

A and F=outlets, attached to powerful air suction pump.

B=mason jars, containing ice water, for absorption of formaldehyde.

C=glass tube, forming with T, a water trapped inlet and outlet for bell G.

D=outlets of bell G.

E=separatory funnel, for admission of formalin to part J.

F=see A.

G=galvanized bell, open at bottom, and immersed in water contained in tank M.

H=water level in tank M.

I=wires to steady and center bell G in tank M.

J=pail, galvanized iron, 14 qt., containing permanganate.

K=hooks supporting bell G in tank M.

L=legs of pail J, to receive its weight on lowering bell G.

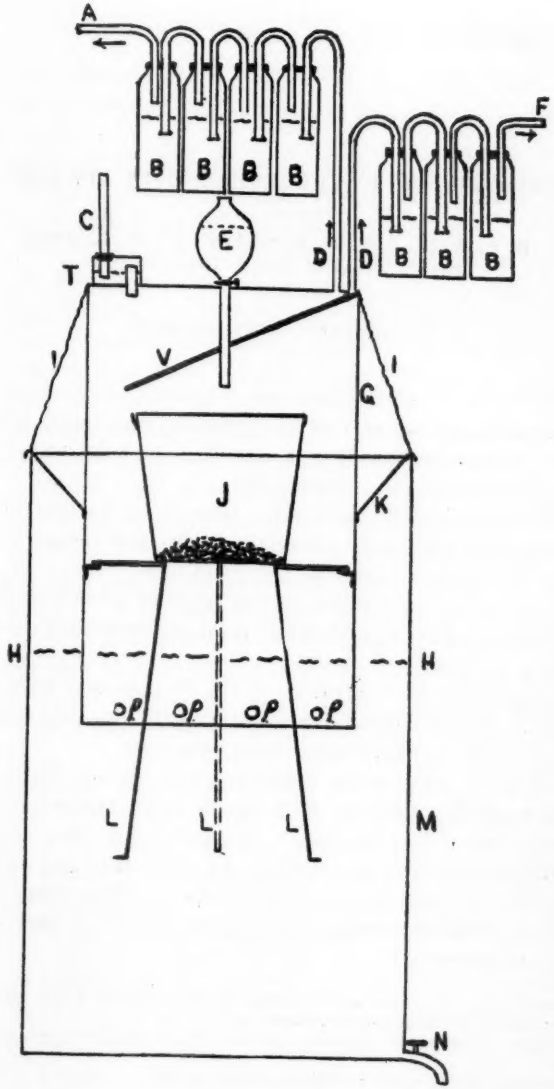
M=tank, galvanized iron, containing water.

N=outlet of tank M.

P=holes near bottom of bell G, to allow escape of surplus gas.

T=trap, see C.

V=veil—a galvanized iron disc, perforated in center for funnel—stem E, to receive and conduct to one side condensation forming on under side of top bell G.


A
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B
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LONGEVITY OF B. TUBERCULOSIS IN SPUTUM*

By B. R. RICKARDS, F. H. SLACK and B. L. ARMS
Boston Board of Health Laboratory

A Preliminary Communication.

Authorities on tuberculosis are practically unanimous in ascribing the greater part of the spread of this disease to infection with organisms from the sputum of individuals suffering from pulmonary tuberculosis.

Comparatively little work has been done to determine how long tubercle bacilli will retain vitality and remain virulent in the sputum under varying conditions.

Dr. Anna I. Von Sholley reports a series of experiments on 36 pigs†. Dr. John Weinzirl gives an interesting report on work with cultures alone‡.

Acting under the suggestion of Dr. Durgin, and with the authority of the Boston Board of Health, this laboratory began a series of experiments June 25th, 1907.

That these experiments might approximate as closely as possible actual conditions, four rooms were obtained in the tenement house districts; No. 1, dry and sunny; No. 2, dry, well-lighted, but with no sunshine, the exposure being to the north; No. 3, dark and dry (lighted by window from air-shaft and window between this and No. 2; No. 4, dark and damp (a basement).

*Read before the Laboratory Section of the American Public Health Association at Winnipeg, August, 1908.

†Report of the Health Department of the City of New York, 1905, Vol. 2, p. 683.

‡Transactions A. P. H. A., Vol. 32, Part 2, p. 128.

These rooms had, of course, to be kept locked, but screened windows were left open in order to obtain circulation of air.

Owing to the difficulty of procuring suitable rooms but two were ready June 25th, Nos. 2 and 3, experiments being started in Nos. 1 and 4 on July 9th.

Technique. Pieces of wooden tongue depressors (representing wood-work) and woolen carpet (representing carpet or rug) about $1\frac{1}{2}$ by $\frac{1}{2}$ inches were immersed over night in a jar of mixed tubercular sputum obtained from one of the city institutions, a separate sample being obtained for rooms 1 and 4. Controls on both were positive.

The pieces of carpet were simply laid on the floors of the rooms but the pieces of wood were held up by string supports so that both sides might be exposed. The samples were collected in sterile test tubes, care being taken to flame the collecting forceps in alcohol that no tubercle bacilli might be carried from one sample to another.

On arrival of the sample at the laboratory about 3 c. c. of sterile water was added to it, and it was allowed to stand 4 to 5 hours. It was then thoroughly rubbed up, and about 1 c. c. of the suspension thus obtained injected subcutaneously into a guinea pig, all tests being made by animal inoculations.

No test was considered positive unless (a) organisms were demonstrated from the lesions or (b) typical pathological lesions were demonstrated microscopically. (In a few instances, usually occurring when the pig died having been inoculated but three or four weeks, it was necessary to make sections from the liver or the spleen.)

First Experiments.

Collections and inoculations were made each Tuesday and Friday until August 23rd. No positives were obtained from Rooms 1 and 4. Two positives on wood were obtained from

Room 2, three and ten days after seeding. Two on wood from Room 3 after 10 days' and 14 days' exposure.

Owing to the fact that no positives were obtained from Rooms 1 and 4, it was decided to repeat the tests, using the same sputum in all the rooms, but as the day when the rooms were seeded was cloudy, another sputum was obtained for use in the sunshine experiments in Room 1. Mixed sputum was used as in the previous experiments.

Second Experiments.

Rooms 2, 3 and 4 were seeded September 6th, and collections made on the 10th, 13th, 16th, daily to the 28th, 30th, October 2d and 4th. Four positives were obtained from Room 2, all being on carpet, after 12, 21, 24 and 28 days' exposure.

Three positives from Room 3, one on carpet after 17 days, two on wood after 10 and 19 days.

Four positives from Room 4, three on carpet after 4, 13 and 17 days; one on wood after 4 days.

Room 1 (sunlight experiments) was seeded September 26th, and collections made hourly for the first day and then discontinued on account of rain. Six collections from each were made, nine being positive and three unsatisfactory, positives being obtained up to the end of the six hours' exposure.

Owing to the difficulty of conducting the experiments, the rooms being located about two miles from the laboratory and at some distance from each other, and to the inconsistency of the results obtained, many negatives being followed by a positive in several instances, it was decided to run a new set of experiments in the laboratory itself where the varying factors could be more directly under our control.

RESULTS OF FIRST SET OF T. B. EXPERIMENTS

Date	Room 1 Carpet	Room 1 Stick	Room 2 Carpet	Room 2 Stick	Room 3 Carpet	Room 3 Stick	Room 4 Carpet	Room 4 Stick	Totals Pos	Neg	Uns	Total
June 25			Seeded		Seeded							
June 28			−	+	uns.	uns.			1	1	2	4
July 2			−	uns.	−	−				3	1	4
July 5			−	+	−	+			2	2		4
July 9	Seeded		−	−	−	+	Seeded		1	3		4
July 12	−	−	−	uns.	−	−	uns.	−		6	2	8
July 16	−	−	−	uns.	−	−	uns.	−		6	2	8
July 19	—	—	−	−	−	−	−	−		8		8
July 23	−	−	uns.	uns.	−	uns.	−	−		5	3	8
July 26	−	−	−	uns.	−	−	−	−		7	1	8
July 30	−	−	−	−	−	−	−	−		8		8
Aug. 2	−	−	−	−	−	−	−	−		8		8
Aug. 6	−	−	−	−	−	−	−	−		8		8
Aug. 9	−	−	−	−	−	uns.	−	−		7	1	8
Aug. 13	−	−	−	−	−	−	−	−		8		8
Aug. 16	−	−	−	−	−	−	−	−		8		8
Aug. 20	−	−	−	uns.	−	−	−	−		7	1	8
Aug. 23	−	−	−	−	uns.	−	−	−		7	1	8

RESULTS OF SECOND SET OF T. B. EXPERIMENTS

Date of col.	Room 1 Carpet	Room 1 Wood	Room 2 Carpet	Room 2 Wood	Room 3 Carpet	Room 3 Wood	Room 4 Carpet	Room 4 Wood	Pos.	Neg.	Uns.	Tl.
Sept. 10			−	−	−	−	+	+	2	4		6
" 13			−	−	−	−	Uns.	−		5	1	6
" 16			−	−	−	+	Uns.	−	1	4	1	6
" 17			−	−	−	Uns.	−	−		5	1	6
" 18			Uns.	−	−	−	−	−		5	1	6
" 19			−	−	−	−	+	−	1	5		6
" 20			−	−	−	−	−	−		6		6
" 21			−	−	−	uns.	−	−		5	1	6
" 22			−	−	−	−	−	−		6		6
" 23			−	−	+	−	+	−	2	4		6
" 24			−	−	−	−	−	−		6		6
" 25			−	−	−	+	−	−	1	5		6
" 26	(4+ (2 uns)	(5+ (1 uns)	−	−	−	−	−	−	9	6	3	18
" 27			Uns.	−	−	Uns.	−	−		4	2	6
" 28			−	−	−	−	Uns.	−		5	1	6
" 30			Uns.	−	−	−	Uns.	−		4	2	6
Oct. 2			−	−	−	−	−	−		6		6
Oct. 4			Uns.	−	−	−	−	−		5	1	6
									16	90	14	120

The following modifications of technique were used:

1. Sputum obtained from a single individual was used, control inoculations being made long enough in advance of the inoculations to show that we were dealing with a virulent organism.

2. Sputum was thoroughly shaken to obtain uniformity, and a large drop of the mixture thus obtained was placed on each piece of carpet or stick used.

This gives more nearly the condition of sputum as expectorated, although, of course, the amount used was much smaller.

Third Experiments.

For control, on these experiments two pigs were inoculated December 9, 1907, with sputum from a single patient. One of these controls developed so rapidly that it was possible to demonstrate typical organisms from the inoculation site and inguinal glands by December 20; the other autopsied at a later date was also positive.

On December 23 pieces of carpet and stick were seeded with a second sample from this patient.

Part of these were exposed in a box with a glass front and a cloth back on a high bench behind the microscope bench, the front of the box facing the north windows. These specimens thus obtained abundant diffuse light, but no sunlight, conditions corresponding to Room 2 in the previous experiments.

Others were exposed to the air in a box in a dark stock room, all artificial light excluded by a cloth hung over the front, tacked to the top and sides, conditions corresponding to Room 3. Pigs were inoculated December 26th, and every other day thereafter as long as the material exposed lasted.

From the specimens exposed to light and air the following results were obtained:

Carpet, 8 positives, covering 19 days' exposure, one negative being obtained after 15 days, and all being negative after 19 days; tests covered 57 days.

Wood, 12 positives, covering 31 days' exposure. During this time there were two negatives after 25 and 29 days and one unsatisfactory after 21 days. No further positives were obtained, although the tests covered a period of 70 days.

From the specimens exposed to the air, but kept in the dark, results were as follows:

Carpet, 17 positives. The first 16 tests made were positive, covering 35 days' exposure. No positives were obtained in the next thirty days, when as a result of "rubbing up" two specimens together and making an inoculation one positive was obtained. Although this was repeated for the remaining three inoculations, there were no more positives. The tests covered a period of 70 days.

Wood, 42 positives. One negative was obtained after 71 days' exposure, and there was one unsatisfactory test after 39 days. No end point was reached, positive results being obtained up to 88 days. These tests are being repeated.

One hundred and ten pigs are also now under observation in a series of sunshine experiments using sputum deposited on brick as well as wood and carpet, these specimens being exposed to the direct sunlight on the roof of the building in which the laboratory is situated, hourly inoculations being made from 8 A. M. to 6 P. M. Sputum has for some time been exposed and inoculations will soon be made in tests approximating Room 4 (dark and damp).

Subsequent Tests.

Brick, first day's exposure, 9+ from 12 inoculations.
Brick, second day's exposure, 8+ from 18 inoculations.
Brick, latest + after 31 hours' exposure to weather.
Stick, first day's exposure, 3+ from 8 inoculations.
Stick, latest + after 5 hours' exposure.
Carpet, 2 positives, after 1 and 7 hours' exposure.

Although by no means ready to draw final conclusions from this work the results of the experiments so far concluded indicate:

1. In order to obtain consistent results in experiments of this kind (a) sputum from a single individual which has been tested and found to be virulent should be used; (b) the sputum should be thoroughly mixed by agitation in order that any particle may be a fair sample of the whole; (c) all the conditions should be under the control of the investigator, weather necessarily being excepted.

2. Tubercle bacilli in sputum deposited on carpet will die out much more rapidly than when deposited on wood.

3. As on wood in the dark and dry tests virulent bacilli persisted for three months, and end point not being reached, it is evident that sputum of tubercular patients cannot be too carefully cared for.

4. It is also apparent that the so-called "tubercular houses" are a real menace to the health of a community.

Date	Approx No. 2 Carpet	Approx No. 2 Wood	Approx No. 3 Carpet	Approx No. 3 Wood	Pos.	Neg.	Unsat	Totals
Dec. 26	+	+	+	+	4			4
" 28	+	+	+	+	4			4
" 30	+	+	+	+	4			4
Jan. 1	+	+	+	+	4			4
" 3	+	+	+	+	4			4
" 5	+	+	+	+	4			4
" 7	−	+	+	+	3	1		4
" 9	+	+	+	+	4			4
" 11	+	+	+	+	4			4
" 13	−	uns.	+	+	2	1	1	4
" 15	−	+	+	+	3	1		4
" 17	−	−	+	+	2	2		4
" 19	−	+	+	+	3	1		4
" 21	−	−	+	+	2	2		4
" 23	−	+	+	+	3	1		4
" 25	−	−	+	+	2	2		4
" 27	−	−	−	+	1	3		4
" 29	−	−	−	uns.		3	1	4
" 31	−	−	−	+	1	3		4
" 2	−	−	−	+	1	3		4
" 4	−	−	−	+	1	3		4
" 6	−	−	−	+	1	3		4
" 8	−	−	−	+	1	3		4
" 10	−	−	uns.	+	1	2	1	4
" 12	−	uns.	uns.	+	1	1	2	4
" 14	−	−	−	+	1	3		4
" 16	−	−	−	+	1	3		4
" 18	−	−	−	+	1	3		4
" 20		−	−	+	1	2		4
" 22		−	−	+	1	2		3
" 24		−	−	+	1	2		3
" 26		uns.	+	+	2		1	3
" 28		−	−	+	1	2		3
Mar. 1		−	−	−		3		3
" 3		−	−	+	1	2		3
" 5				+	1			1
" 7				+	1			1
" 9				+	1			1
" 11				+	1			1
" 13				+	1			1
" 16				+	1			1
" 18				+	1			1
Totals	28	35	35	42	77	57	6	140

The following papers read at the meeting of the Laboratory Section at Winnipeg were not received for publication:

"Experimental Leucocytosis in the Cow's Udder," Conrad Hoffman.

"The Individual Animal as a Factor in the Germ Control of Milk Supplies," E. G. Hastings and Conrad Hoffman.

"The Waters of the Great Lakes," R. B. Dole.

"Some Studies of the Physiological Leocyte Content of Cow's Milk," B. H. Stone and L. P. Sprague (Journal of Medical Research, 1909).

"A Comparison of Practical Methods for Determining the Bacterial Content of Milk," P. G. Heineman (Journal of Infectious Diseases, Vol. V., p. 412).

"Stability and Putrescibility in Sewage Filter Effluents," E. B. Phelps.

"Tests for the Significance of Gas-Producing Bacteria in Milk," D. D. Jackson and H. W. Streter.

Vital Statistics Section

THE MARYLAND BIOMETER AND SOME OF ITS MATHEMATICAL RELATIONS*

By MARSHALL LANGTON PRICE, M.D.
Baltimore

The science of vital statistics is to the sanitarian what the chart and compass is to the navigator. It can no more be expected that the sanitarian will steer a straight course without the aid of vital statistics, than that the navigator will reach his goal without his chart and compass. There is, however, this important difference: the sailor cannot go wrong and not know it, but the hygienist can steer a false course and never know how many lives his mistakes have been the means of wrecking.

The hygienist moreover does not start out with a definitely fixed goal, but must steer his course according to the conditions he meets in his voyage. He must meet constantly changing and complex conditions, all of which require close study and observation for which, through the irony of fate, circumstances seldom allow time, even for the careful study of the simplest elements. If all these complex and changing elements allow of generalization, the broad purpose which the sanitarian must keep in mind is threefold. First, to increase the birth rate; second, to diminish the death rate; third, to increase the duration of life. The last of these three main elements is the most important, and is the true measure of sanitary efficiency; for the death rate may be low and yet the deaths may all have occurred in young per-

*Read before the Vital Statistics Section of the American Public Health Association at Winnipeg, August, 1908.

sons from wholly preventable causes, and the duration of life fall far below a proper median, or the death rate may be high but the deaths have occurred among the old whom nature has largely removed from the influence of sanitary government, and, consequently, the duration of life will be above the median. The birth rate has been shown, futher, to be, at least to some extent, independent of sanitary conditions and indeed of sanitary control.

As we must recognize the duration of life to be the best, and, indeed, the only proper measure of sanitary efficiency, it is most surprising that the public health authorities have not generally made use of the only means at their disposal for measuring the efficiency of their work. The only attempts that have been made by the health authorities of the states and cities of the United States along this line, have been the publication of tables giving the average age at death, upon the assumption that this figure is equal or equivalent to the duration of life. Our most eminent statisticians have so frequently pointed out the fallacy of this argument that it is scarcely necessary to refer to it here. The real reason why life tables are not more frequently used is, doubtless, because of their complexity and of the fact that the life tables in common use are not well adapted to the purpose of sanitary government. It will, perhaps, best illustrate this point to refer briefly to the history of life tables and their use down to the present day.

About the year 1855 the late Dr. Farr, then Registrar-General of England, constructed a series of tables, later to become in familiar use by actuaries and other statisticians under the name of "life tables." To such a table as affording an efficient measure of the "life" of a community Dr. Farr applied the name "biometer." These tables marked a new and wide field in the handling of statistics, and particularly in that branch of statistics known as "vital statistics." Dr. Farr's tables were applied to the whole people

at large, but their use in the present day (certainly in the United States), is largely confined to a special class of people with whom the insurance companies do business. The insurance tables are constructed from accepted risks and are known as "Healthy Males" or "Healthy Females" tables. Such tables are generally constructed to show the expectancy of life at certain age periods, or to show the "probability of living one year." Such tables constructed to apply only to the healthy, are necessarily not of great advantage to the sanitarian whose work mainly is concerned with the diseased. These tables have, moreover, another serious defect. The sanitarian is not only interested in knowing the general duration of life, or the expectation of life at a given age period, but in noting the particular period at which the loss or gain appears. The expectancy of life is, further, only an average of the condition existing beyond the age period for which the calcu-

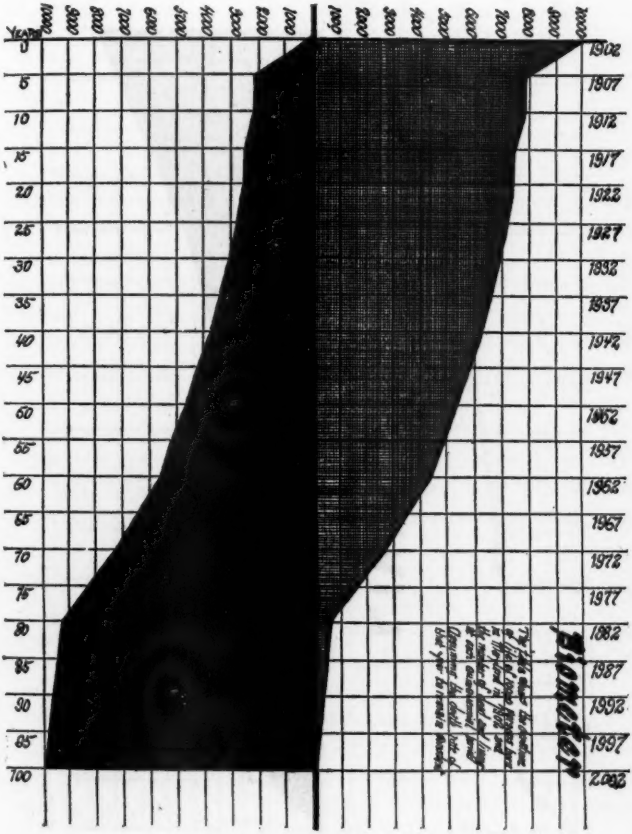
TABLE I.

MARYLAND, 1906—BIOMETER TABLE

Ages	Per Cent.	Estimated Population	Deaths	Mortality per 1000 Annual	Mortality per 1000 Age Period	Deaths in Age Period	Survivors of 10000 Born 1906	A. D.
0. 5	11.36	145976	6127	41.97	209.65	2099	7901	1911
5.10	11.21	144048	501	3.48	17.40	130	7771	1916
10.15	10.66	136981	384	2.83	14.15	110	7661	1921
15.20	10.13	130171	615	4.73	23.64	181	7480	1926
20.25	9.06	116421	—	—	—	—	—	—
25.30	8.58	110253	1677	7.39	73.90	553	6927	1936
30.35	7.17	92135	—	—	—	—	—	—
35.40	6.68	85838	1594	8.96	89.60	621	6306	1946
40.45	5.80	74530	—	—	—	—	—	—
45.50	4.73	64521	1780	19.99	199.90	1261	5045	1956
50.55	4.07	52300	—	—	—	—	—	—
55.60	3.09	39707	1870	20.33	203.30	1026	4019	1966
60.65	2.57	33025	—	—	—	—	—	—
65.70	1.80	23130	2172	38.67	386.70	1554	2465	1976
70.75	1.23	15806	—	—	—	—	—	—
75.80	0.79	10152	2158	83.13	831.30	2049	416	1986

lation is made. Hence if graphic curves are used, eccentricities in the curve caused by unusual conditions at a given age period are obscured or lost by compensating eccentricities at later age periods. For these reasons a table of survivorship is used in the construction of the "Maryland Biometer." Tables of survivorship are not new in vital statistics, but the merit which is claimed for the "Maryland Biometer" is its simplicity of construction from figures which are always available, and the manner of indicating the survivorship graphically. This Chart is shown in figure 1. It is possible by applying a compass to any part of the curve to get the number of living and the number of dead out of the unit population at the year of calculation. The Maryland Biometer is like other charts of the same character, prognostic of the future; that is, it assumes the mortality conditions of the year for which the calculation is made to remain constant for a certain period (eighty years is taken as a basis for reasons which will appear upon examining the chart). Ten thousand is taken as a unit of population, and a population of ten thousand, born in the year for which the biometer is constructed, is traced under the conditions of that year for eighty years subsequent. The biometer shows how many will be living, and how many dead at the succeeding quinquennial periods. This calculation is approximately correct and readily admits of comparison with preceding or succeeding years. The following data are necessary for the calculation (all of which is given for the year 1906 in Table 1): 1. Deaths by quinquennial periods for 1906 (taking 1906 as an example). 2. Estimated population for 1906. From these data we can obtain: 3. Death rate annually for the quinquennial periods. 4. Death rates for the age periods. If these figures are applied first to ten thousand persons between 0 and 5 years, and then to the survivors (after deducting the deaths in the manner shown in Table 1), we will

obtain the figure shown in Fig. 2, in which the broken line indicates the survivors from the year 1906 to 1986. (The upper light portion represents the living, and the black lower portion the dead.)



Maryland Biometer
FOR THE MEDIAN PERIOD
1902 to 1905 inc.
The individual Biometers
of 1902, 1903 1904 and
1905 are superimposed
LIVING
DEAD
THOUSANDS
Median Quinquennial Periods

As the human race is necessarily mortal, all of the living population represented above the base line must eventually cross the line and appear among the dead population below the line, but it is in the manner of their crossing (that is in the form of the curve), by which we measure the vital condition of the community. The ideal biometer will have a broad flat apex, not declining materially until the seventieth year, when the degenerations of age, now beyond the control of sanitarians, become the predominate influence. The following is the survivorship table in Maryland for the year 1902:

Number born in 1902	10,000
Number reaching the age of 5 years (A. D. 1907)	7,885
Number reaching the age of 10 years (A. D. 1912)	7,745
Number reaching the age of 15 years (A. D. 1917)	7,640
Number reaching the age of 20 years (A. D. 1922)	7,457
Number reaching the age of 30 years (A. D. 1932)	6,913
Number reaching the age of 40 years (A. D. 1942)	6,346
Number reaching the age of 50 years (A. D. 1952)	5,591
Number reaching the age of 60 years (A. D. 1962)	4,512
Number reaching the age of 70 years (A. D. 1972)	2,770
Number reaching the age of 80 years (A. D. 1982)	665

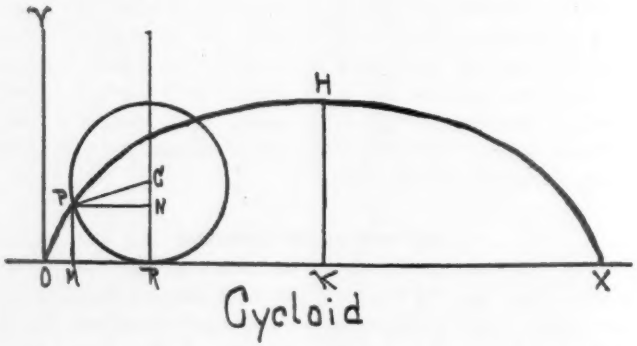
These figures with their differences furnish the plus and minus ordinates of the chart.

Properties of the Biometer

If we examine the Biometer, as shown in Fig. 1, we will observe that the life line (above) is a curve consisting of three parts, each conforming to a distinct equation. It is advisable to consider only that part of the curve constructed from the above table and extending from birth to the eightieth year, eliminating all ages over eighty, both because the population over eighty is too small to furnish

even approximate results, and because of the well-known inaccuracy of ages returned on death certificates after the eightieth year. There then remains two curves to be considered in the life line, one markedly eccentric extending from birth to the fifth year, the remainder fairly regular up to the eightieth year. The first five years of life show such a heavy mortality that they cannot be made to conform to any equation representing the later years of life.

The young recruits in life's battle are met on their arrival on the field by such a hot fire that they are literally decimated before they can take cover and secure themselves from all but the chance bullets that they meet with during the remainder of their life. The first five years must thus be considered a period of adjustment. Eliminating the ages below five we have left a curve somewhat similar to the transcendental curve known as the "cycloid"—that is, the second half of the branch, or the portion HX of the curve OHX.



Cycloid

The common equation of the cycloid is as is well known,

$$x = r \text{ vers.} -1 \frac{y}{r} + \sqrt{2ry - y^2}$$

Since we only desire to compare the ordinates of the cycloid, we may use the simultaneous equations,

$$x=r(\Theta-\sin.\ \Theta)$$
$$y=r(1-\cos.\ \Theta)$$

which are the simultaneous equations of the cycloid.

Since we wish further only the values of the ordinate, y, at any point of the curve, we have only use for the second equation,

$$y=r(1-\cos.\ \Theta)$$

It now remains to determine the values of y in the portions of the cycloid whose ordinates correspond to the ordinates of the several quinquennial periods of the Biometer; in other words, to determine how closely the Biometer curve corresponds to the cycloidal curve. As we commence the cycloidal curve from the fifth year and extend it to the eightieth year, the ordinate of the fifth year will represent the line HK, which is equal to a surviving population of 7885.

Hence D=7885 (diameter of generatrix)

r=3942.5

Θ=the angle of revolution (PCR in the figure).

Since the generatrix will make one complete revolution from O to X, Θ will represent values from 0° to 360°, and since there are fifteen age periods from H to X or from 180° to 360° each successive angle will be greater than the preceding by 12° 0′.

At 5 years	Θ=180° 0′	nat. cos.	1.000000 with — sign
10 years	Θ=192° 0′		0.978148
15 years	Θ=204°		0.913545
20 years	Θ=216°		0.809017
25 years	Θ=228°		0.669131
30 years	Θ=240°		0.500000
35 years	Θ=252°		0.309017
40 years	Θ=264°		0.104528

45 years $\Theta=276^\circ$	0.104528 with + sign
50 years $\Theta=288^\circ$	0.309017
55 years $\Theta=300^\circ$	0.500000
60 years $\Theta=312^\circ$	0.669131
65 years $\Theta=324^\circ$	0.809017
70 years $\Theta=336^\circ$	0.913545
75 years $\Theta=348^\circ$	0.978148
80 years $\Theta=360^\circ$	1.000000

We may now determine the values of y in the equation

$$y=r(1-\cos.\ \Theta)$$

where r=3942.5 and the successive values of Θ are as given in the above table.

To determine the population surviving at any given age period according to the cycloidal curve, we must first determine the population surviving at the end of five years. To do this we subtract 20% of the original population then:

P—20%P=number living at the end of five years.

$$D=P-20\%P$$

$$r=\frac{P-20\%P}{2}$$

and the value of Θ for the given age period will be the proportionate part of the arc between 180° and 360°, representing the ages from 5 years to 80 years.

Thus at 21 years

$$\Theta=21/75\times 180^\circ=50^\circ/24'$$

which will give an approximate result when applied in the equation. For the population of 10,000 used in the construction of the Biometer we obtain the value of y (or surviving population) at quinquennial periods as follows:

In the equation $y=r(1-\cos.\ \Theta)$, at 5 years $\Theta=180^\circ$, $\cos.\ \Theta=1$; hence

$$y=3942.5(1-\cos.\ 90^\circ)$$

and since Θ has the minus sign in this part of the curve

$$y=3942.5\times 2=7885$$

which gives the population at 5 years equal to the axis of the cycloid HK.

At the age of 10 years $\Theta=192^\circ\ 0'$, and cos. $\Theta=0.978148$.

Apply these values in the above formula,

$$y=3942.5\times 1.978148=7809$$

The values of y in the cycloid from five to eighty years appear in the following table:

At 5 years	y=7885
10 years	y=7799
15 years	y=7544
20 years	y=7132
25 years	y=6580
30 years	y=5914
35 years	y=5161
40 years	y=4355
45 years	y=3530
50 years	y=2724
55 years	y=1971
60 years	y=1305
65 years	y= 865
70 years	y= 341
75 years	y= 87
80 years	y= 0

A more nearly approximate result will be obtained by considering the cycloidal curve to terminate at the 95th year; this curve will also be more in accordance with the facts. In this equation $\Theta=10^\circ\ 0'$.

At 5 years	y=7885
10 years	y=7825
15 years	y=7647
20 years	y=7357
25 years	y=6962
30 years	y=6477

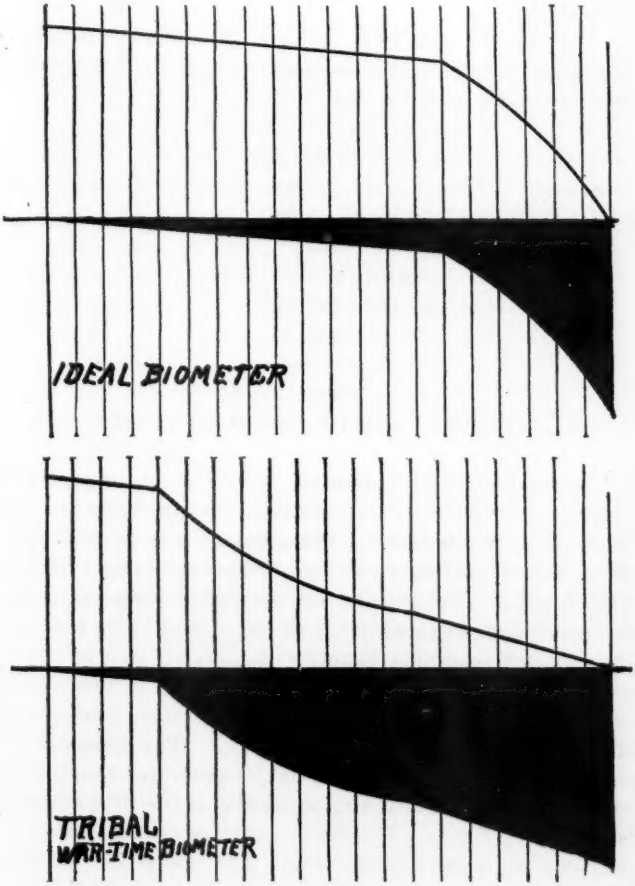
35 years y=5914
40 years y=5291
45 years y=4527
50 years y=3943
55 years y=3258
60 years y=2594
65 years y=1971
70 years y=1408
75 years y= 923
80 years y= 523
85 years y= 238
90 years y= 60
95 years y= 0

It will be seen by comparison of the figures of this last table with those of the Biometer that they correspond approximately only up to the thirtieth year.

It is in the middle period of life that sanitation has produced its appreciable effects, and the cycloid can only be considered a true "life curve" for savage and semi-civilized communities. It may be characterized as the "natural life curve" in contradistinction to the "artificial life curve" seen in the Biometer of civilized communities.

Different Varieties of Biometers

The profits of hygiene are to be gained almost wholly in the control of communicable disease, congenital deficiencies and senile degeneration being yet wholly beyond sanitary control; hence the ideal biometer should have a broad flat apex, almost level until the seventieth year, after which it declines with greater or less abruptness. This ideal curve is shown in the figures:



The biometric method can be applied with especial facility to a portion of the population, a selected number, or class.

The biometer of a savage tribe during war would present the form shown in the figure.

Example:—

During the year 1833, 105,463 children were born in a European empire. How many will be living in 1855, assuming their mortality to follow the cycloidal curve?

5-95 years $\Theta = 180° - 360°$

5-22 years $\Theta = 180° - 224°$

Population surviving after 5 years, 105,463—21,093=84,370

Population surviving at 5 years = y.

$$y = r(1 - \cos. \Theta)$$

$$y = 42{,}185(1 - \cos. 224°)$$

log. 42,185=4.625159

log. 1.7193=0.235352

4.860511 (log. y)

Nat. No. 72,529=Population surviving at 22 years. *Ans.*

The figures for the biometer shown so far are for the year 1902, while the charts show a median figure for the years 1902-1905 inclusive. These figures may be well compared with the biometer of 1906, shown in the upper lines in Figs. 1 and 2. The biometer for this year is distinctly abnormal and differs more widely from the cycloid curve than the curve of any preceding biometer, as may be seen by reference to the figures. The normal biometer is a homologous curve, uniformly convex throughout, and conforming rather closely to the cycloidal curve. The biometer of 1906, however, shows two marked irregularities which may be noticed in the concavities appearing at the thirtieth and fiftieth years, Fig. 3. The whole curve, moreover, falls considerably below the cycloid curve. The reason for this unfavorable showing in 1906 has not yet been worked out.

The biometer may be used in another way to establish a standard. It will be noticed that there are 160 squares in the table from 5 to 80 years. If all the persons shown in the chart survived to their eightieth year all of the

squares would be included within the biometric curve. The perfect biometer could, therefore, be indicated by the equation $\frac{160}{160}$, while the usual biometer would be approximately $\frac{124}{160}$. A more accurate result can be obtained by computing the area of the trapezoids not included in the biometer curve by the equation (Area=½ product of the parallel sum of the sides by the altitude).

In order to make the biometers of successive years comparable all are drawn to the same scale and the ratio of the base to the altitude is made the same as in the cycloid, viz.: 100 : 157*. The most convenient method is to make the base 157 Cm. and the altitude 100 Cm. This makes a biometer of the size shown.

It has been shown, I hope, how readily a biometer can be constructed from the figures available in the office of every registrar of vital statistics, and I hope the use of biometers will become more general and their value more fully appreciated by sanitary administrations in this country.

*This ratio has not been followed by the draughtsman.

Born 1906 100000	By Calculation	Cycloid equivalent $y = (1 - \cos x)$
Surviving 5 years later 1911	7901	7901
Surviving 10 years later 1916	7771	7861
Surviving 15 years later 1921	7661	7779
Surviving 20 years later 1926	7489	7657
Surviving 30 years later 1936	6927	7131
Surviving 40 years later 1946	6386	6730
Surviving 50 years later 1956	5045	5906
Surviving 60 years later 1966	4019	4765
Surviving 70 years later 1976	2445	2688
Surviving 80 years later 1986	416	0

THE MASSACHUSETTS ASSOCIATION OF BOARDS OF HEALTH

JULY QUARTERLY MEETING

Boston, Mass.

The quarterly meeting of the Association was held at Gallup's Island, Boston Harbor, on Thursday, July 22, 1909, President Walcott presiding.

The Association on recommendation of the Executive Committee elected the following members of the Association:

Herbert M. Larrabee, M. D., of the Tewksbury Board of Health.

Fred H. Rounds, of the Melrose Board of Health.

Gilman L. Chase, M. D., Milk Inspector and Bacteriologist, Clinton Board of Health.

Henry D. Chadwick, M. D., Superintendent Westfield State Sanitorium, Westfield.

Thomas E. Maloney, V. S., of the Fall River Board of Health.

E. W. Babson, M. D. V., of Gloucester.

Calvin G. Page, M. D., of Boston.

W. G. Turner, M. D., of the Fall River Board of Health.

Winthrop S. Blanchard, M. D., Boston Board of Health Laboratory, 30 Huntington Ave., Boston.

Cecil K. Blanchard, B. S., Sanitary Expert and Bacteriologist for Wellesley.

Charles S. Holden, M. D., of the Attleboro Board of Health.

Ralph P. Kent, M. D., of the Attleboro Board of Health.

J. Albert Simpson, Inspector of Milk, Milton.

H. H. Nevers, M. D., Bacteriologist, Lawrence Board of Health.

Alfred C. Smith, M. D., of Brockton.

Dr. Darius W. Gilbert, Inspector of Animals, Cohasset.

DR. SWARTS. I would like to place in nomination for membership on the honorary list the name of Mr. Burt R. Rickards, who previously was (or is) a member of this Association, actively connected with its interests, but who has removed from Boston to the work of the State Board of Health of Ohio. He was connected with the city board as bacteriologist, having charge of its laboratory, and is connected with the publication of this Association, as I understand it, as editor.

I would take the privilege of presenting his name for the honorary list. (Motion carried.)

REPORT OF THE COMMITTEE ON MILK LEGISLATION.

The Committee on Milk Legislation, appointed one year ago, desires to report that it was successful in securing the legislation sought for.

As was reported quite fully at the regular meeting last October, the Committee ascertained the sentiment of practically all the local boards of health of the state, which was overwhelmingly in favor of placing all matters connected with the inspection of milk under the jurisdiction of the local boards. As directed by vote of the Association at that meeting the Committee introduced a petition for such legislation and appeared at the hearing given by the legislative Committee on Public Health.

Quite a number of health boards sent representatives to help at this hearing. We met some opposition from several sources but secured a favorable report on the bill from the legislative committee. The bill passed the House easily but met with considerable opposition in the Senate. Here it was amended in two particulars. One provided that any removals from office of milk inspectors should be in accordance with civil service rules. This amendment we did not regard adversely. The other amendment provided that in towns the compensation of milk inspectors should be determined by the selectmen. This amendment we did not regard so favorably as it is obvious that in case the selectmen of any town were not in sympathy with the efforts of the board of health in the matter of milk inspection by virtue of controlling the finances they could easily stop the work. In this connection it may be said that if any hardship is experienced by reason of this, action can be taken at the

next session of the Legislature to have the matter adjusted so that the boards of health of towns can also govern the financial side.

The Senate amendments were, after some skirmishing, concurred in by the House and the bill was signed by the Governor on May 19th and became a law on that date.

The text of the Act is as follows:

An act to provide for the appointment of inspectors and collectors of milk by boards of health.

Be it enacted, etc., as follows:

Section 1. The boards of health of cities shall, and boards of health of towns or the selectmen acting as such boards, may, appoint one or more inspectors of milk for their respective cities and towns. In cities such inspectors, after appointment, may be removed from office in accordance with the provisions of chapter three hundred and fourteen of the acts of the year nineteen hundred and four; in towns they may be removed at any time by the appointing board. Such inspectors shall have the powers and perform the duties now conferred and imposed by law upon the inspectors of milk, but they shall be under the control of the boards of health appointing them, and shall perform such other duties as the said boards may designate. Their compensation shall be determined by the boards of health in cities, and by the selectmen in towns appointing them.

Section 2. The collectors of milk provided for by section fifty-two of chapter fifty-six of the Revised Laws shall hereafter be appointed by the board of health, or by the selectmen acting as such a board, in each city or town, and the said boards may also designate and employ any member of the board or any agent or employee thereof, to act as a collector of milk, and the collectors of milk so appointed or designated shall have the powers and perform the duties conferred or imposed by law upon the collectors of milk.

Section 3. Section fifty-three of said chapter which provides for the licensing of venders of milk in vehicles is

hereby amended by adding at the end thereof the following:—If the applicant for a license fails to comply with any regulation established by the board of health in the city or town where the application is made, a license may be refused until he has complied with such regulation; and a license granted under this section may be revoked at any time for failure to comply with any such regulation. If a license is refused or revoked under this provision, an appeal may be taken to the state board of health, whose decision shall be final and conclusive.

Section 4. So much of sections fifty-one and fifty-two of said chapter fifty-six as is inconsistent herewith is hereby repealed.

Section 5. This act shall take effect upon its passage; but inspectors and collectors of milk in office at the time of the passage of this act shall continue in office until their successors are appointed hereunder. Approved May 19, 1909.

GEORGE E. BOLLING, Chairman.
GEORGE L. TOBEY, M. D.
ELLIOTT WASHBURN, M. D.

The report of the committee was accepted and on motion of Dr. Durgin was continued for the ensuing year with the addition of two members to be appointed by the President. By vote of the Association, on motion of Dr. Durgin, the committee was instructed to draw up a milk regulation as a guide for such regulations by the boards of health of the State; a report on same to be made at the next meeting of the Association.

TYPHOID FEVER: INCIDENCE OF THE DISEASE AS CONTRACTED WITHIN THE MASSACHUSETTS GENERAL HOSPITAL FROM 1899 TO 1908.*

By LESLEY H. SPOONER, M. D.
Boston, Mass., formerly House Pupil at Mass. Gen. Hospital

That typhoid fever is a contagious disease has been known for a great many years, and the method of its transmission was indicated as early as 1856 by Budd of Bristol, who believed that in this disease the stools were the essential agents in the transmission of the infectious process.

Little real advance, however, could be made in the study of the disease and its prevention until its actual cause was discovered by Eberth in 1880. Since then the typhoid germ has been demonstrated in a number of other excretions besides the feces, notably in the urine, and to a lesser degree in the sputum.

In the efforts to prevent the further distribution of typhoid fever, it is but natural that general hospitals and other large institutions should be the first and foremost to make and carry out strictly regulations concerning disinfection, and a strong effort is made at the Massachusetts General Hospital to impress upon the house physicians, nurses, ward-tenders, in fact, any persons brought into any relation with typhoid patients, the necessity for the greatest care in order to prevent the extension of the disease.

* An investigation suggested by Mark W. Richardson, M. D., Secretary of the State Board of Health, and carried out with the hearty co-operation of the hospital authorities. Financial aid for the work has been furnished by Dr. Richardson, Mrs. Robert S. Bradley of Boston, and Mr. Frederic W. Lord of New York.

It is the purpose of this paper to point out that in spite of this careful instruction, given to people of intelligence above the average, the incidence of typhoid fever within the Massachusetts General Hospital during the past ten years has been far beyond what should properly have been expected. During the period of ten years, from 1899 to 1908, there were contracted within the hospital, apparently from direct or indirect contact, 27 cases of typhoid fever. Of this number, 19 were nurses; 4, ward tenders; 1, morgue tender; 1, kitchen hand; 1, laundress; 1, elevator man.

In order to arrive at the relative importance of these figures, it is, of course, essential to know how many individuals are, as a rule, employed in such an institution. This number naturally varies from time to time, but at present there are employed in the Massachusetts General Hospital about 200 persons, who might be said, in the broadest sense, to be exposed to the disease,—typhoid fever. This number may be divided as follows:

Nurses	119
Ward-tenders	19
Ward maids	18
Laundry men and maids	30
Ambulance men	3
Accident ward and pathological laboratory employees	7

Of these, only the nurses and ward-tenders and those employed in the laundry and pathological laboratory are, in the strictest sense, greatly exposed to typhoid fever. The number of those who might be exposed to the disease, therefore, would be, approximately, 168.

Furthermore, during the same ten-year period, the records show that there were brought to the hospital 12 nurses who had been engaged in outside practice, and who gave positive histories of having cared for, within a few weeks, patients sick with typhoid fever. It must be assumed that these nurses were thoroughly familiar with the procedures

necessary to prevent contamination, though it must be admitted that in private practice it is not so easy to carry them out as in a large hospital.

Of the 27 hospital cases, 6 proved to be "very severe" in character, and two died—both ward-tenders; two were "severe"; 12 ran an "average" but not dangerous course; and 7 were only "mildly" sick. Six cases were characterized by true relapses, and 4 had recrudescence of fever after an initial drop. There were 3 cases of phlebitis, 1 of severe bronchitis, and 1 of otitis media. Four cases had hemorrhages of considerable severity and 2 of these were fatal. In one of these hemorrhagic cases there was perforation of intestines also.

The occurrence of the disease by years was as follows:

1899	2 cases
1900	1 case
1901	2 cases
1902	3 cases
1903	2 cases
1904	6 cases
1905	2 cases
1906	2 cases
1907	3 cases
1908	4 cases

It is apparent that although the number of cases seen annually shows a moderate fluctuation, there has been no actual decrease in the number of cases.

Conclusions:

1. That in the Massachusetts General Hospital the annual incidence of typhoid fever contracted within the institution is high. During the past ten years this has averaged between 2 and 3 cases yearly That is to say, 1.6 per cent. of the nursing force; 2.1 per cent. ward-tenders; or, 1.6 per cent. of all those exposed to the disease have become infected.

2. That a similarly important incidence of the disease is to be noted among nurses engaged in private practice.

3. That the disease contracted under such conditions seems to run a course of more than ordinary severity, with a greater number of complications and with a high mortality.

4. That the disease among the hospital personnel is not diminishing in frequency.

PROTECTIVE INOCULATION AGAINST TYPHOID FEVER.

By MARK W. RICHARDSON, M. D.
Secretary State Board of Health, Boston

The facts, which you have just heard, in Dr. Spooner's paper are very striking, although they are not, of course, new. The danger of contact infection in typhoid fever has been recognized for many years, but it has been taught also that by the exercise of intelligence and special training the danger from this source could be practically eliminated.

Dr. Spooner's figures, therefore, give to the feeling of security with which we have been indulging ourselves a sudden and disagreeable jar. Inasmuch as careful teaching and special training have failed to eliminate the incidence of typhoid fever among those attendant upon the sick, it is apparent that recourse must be had to other methods, and the method which appeals most strongly to us at present is that of specific typhoid inoculation of those exposed or likely to be exposed to this disease.

This method, which has been tried out quite thoroughly in England and Germany in the effort to cut down the occurrence of typhoid fever among the governmental troops, and which is about to be used in the American army, consists in introducing into the human body, by subcutaneous inoculation, varying amounts of typhoid material in the shape of typhoid bacilli which have been devitalized by heat or otherwise. To this inoculation the body responds in a characteristic manner by the production of specific substances antagonistic to the typhiod organisms, so that when, later, the individual is exposed to infection, the body cells

and fluids respond in so sharp and efficient a manner that the infection is nipped in the bud, and does not gain a foothold.

The results in practice of specific inoculation for typhoid fever have been somewhat as follows:

Leishman (Journal Royal Army Medical Corps, Feb., 1909), in reporting the English experiences, states that of the 5,473 soldiers who had been inoculated only 21 became subsequently infected. Of these, two died. Of 6,610 uninoculated in the same regiment, 187 had typhoid, and 26 died.

In confirmation of these results, the Germans found that of 424 typhoids, 324 had not been inoculated. In the uninoculated, the mortality was 11.9 per cent.; of the inoculated, 4 per cent. In the inoculated, the disease was milder and there were fewer complications and relapses.

There being, then, this solid basis of experience to draw upon, it was natural to suggest this method of prevention to the nurses and house staff of the Massachusetts General Hospital. A meeting with them was arranged, therefore, and the situation fully explained by the writer. It was pointed out that according to all previous experience from 2 to 6 of their number were about to be subjected during the coming typhoid season to the dangers and inconveniences of typhoid fever. They were, therefore, urged to submit to typhoid inoculation, which would, assuredly, cause little discomfort and do no harm, and might be the means of saving them from sickness and, perhaps, death. As a result, over fifty nurses volunteered and are now in the process of systematic inoculation. The outcome of this method of prevention cannot, of course, be predicted, and in any event the matter must be viewed with great conservatism. Personally, I have no doubt that the method has a sound, scientific basis, and that time and experience will furnish the knowledge as to details necessary to make it practically effective.

Thus far in this work, very conservative lines have been followed. The goal aimed at has been a method which should accomplish the end desired with as little inconvenience as possible to the individual. We have, therefore, not followed the lead of Wright, the English exponent of this method, who gives two inoculations of very large doses of vaccine—doses, in fact, sufficiently strong to cause severe constitutional symptoms and to confine the individual, possibly, in bed for several days. On the contrary, we have used doses so small as to cause practically no disturbance except a slight local tenderness. Our practice at present is to give four such inoculations (50,000,000 to 100,000,000 in each dose) at five-day intervals. It is hoped that in this way the immunity secured may be sufficient, and that the general introduction of the method may not be prejudiced by the severity of the reactions produced.

In this connection it is interesting to note that two inoculations given to each of five individuals produced in their blood agglutinating powers ranging anywhere from 1 to 100 up to 1 to 1,000, the latter figure being one very rarely seen in the presence of actual typhoid fever. Of course, a high agglutinating power of the blood does not necessarily mean a correspondingly high immunity of the individual, but these results obtained from such small doses of vaccine are certainly very suggestive.

A point of great interest and importance is, of course, the length of time during which this immunity, artificially acquired, may be supposed to last. English writers think that the immunity lasts from two to three years. This is a point, however, upon which no authoritative statements can yet be made.

As has been stated, the method pursued up to this time has been that of subcutaneous inoculation. There are, however, facts which lead me to believe that the subcutaneous method may in the future be replaced by the administration of these typhoid vaccines by mouth. A number of inves-

tigators have shown that with typhoid bacilli, and some other bacteria, a considerable amount of immunity may be produced by the administration of dead germs by mouth. If it should prove that this method is effective, the advantage gained would be two-fold at least. In the first place, the local tenderness after inoculation, slight though it be, would be eliminated, and, secondly, we might hope to get an increased local intestinal immunity. That is to say, the intestinal mucus membrane, being acted upon directly by the vaccine, should become more strongly resistant than would be probable as a result of indirect subcutaneous inoculation.

The result should be, under such circumstances, that any living typhoid bacilli taken in through the alimentary tract would find an impassable barrier in the now strongly fortified intestinal cells.

Granted that this method of immunization is an efficient one, it is easy to see that the extent of its usefulness will be very wide, for there can be no doubt that the same principles of protective influence will apply in other intestinal diseases, such as cholera, dysentery and other diarrhoeal affections.

The problem, therefore, at present, is to demonstrate the value of these methods in large bodies of individuals, such as army troops and hospital nurses. The method should be applicable, in fact, it has been used, with success in large institutions, such as insane asylums, in which typhoid fever has broken out.

Finally, I have not the slightest doubt that, within a few years, protective inoculation will be resorted to in any community in which the disease becomes epidemic. In fact, I believe that any of you, gentlemen, in your capacity as protectors of the public health, would be justified, in the presence of an epidemic of typhoid fever, in recommending and urging upon the people of your constituency the use of such specific inoculation.

THE PRESIDENT. I think this Association will agree with me that there is no subject that comes closer to the powers of the boards of health, state and municipal, than the questions raised by the papers that have been read to you this afternoon. A great many of us know what the difficulties are of a quarantine against a case of diphtheria with persistent organisms in the throat, but what comparison is to be drawn between that case,—a case of obstinate diphtheria infection,—and such cases as have become familiar of late years in typhoid fever? Can you tell us something, Dr. Swartz, about the responsibilities of a state board of health in matters of this sort.

DR. SWARTS. I don't know that I can handle the subject as it should be handled; but it evidently is a question which state boards of health should try to control by knowing of the possibilities of the transmission of the disease. Referring to the first paper, it would seem almost impossible that the disease should exist as it has in an institution of that kind. We can understand that ward tenders might be careless, but if nurses, who are constantly taught that this particular means of infection is from fecal material, are careless, it would seem as if the screws were loose somewhere. Of course we have to take into consideration the individuality of the people who are handling the patients, and their general carelessness. That it would occur perhaps more readily with the outdoor nurses, spoken of in the first paper, I am not surprised. In a family where there is a lack of convenience for caring for the sick, and a lack of responsibiltiy on the individual, the family being by themselves, having no internes, and no visiting physicians over them, it would seem as if there might be more carelessness. But knowing the disease, what it is, where it comes from, it would seem as if we might readily avoid infection from typhoid fever.

And as to the inoculation principle, I think it would be

a difficult matter, perhaps, to introduce it in general, owing to the lack of confidence which the public may have in the germ theory even at the present time. To ask them to have something introduced into their system, even if they belonged to the army, seems like asking a good deal of them. We have come to the stage of believing that vaccination against smallpox is a perfect thing. We could do the same thing with this. But to work it out at the present time in cold blood, without these figures and statistics, I think would be a difficult matter for boards of health to have any influence whatever. The subject of this second paper is one which has been brought out more recently, with a great deal more interest, and I think will attract more attention as the time goes on. I am very glad to hear that the inoculations have been introduced in the hospital, and that the attendants are willing to submit to the test. It is best to wait for a few years and see whether these statistics continue or not.

THE PRESIDENT. It is always a great advantage for the public health authorities to submit to the criticism of the large practitioners of medicine, who have other views naturally on some subjects than those which are entertained by local boards of health. We have one of our friends here, who not only has that knowledge, but who also had in his day a large institutional experience. I will ask Dr. Stevens to say something on the subject.

DR. STEVENS. There is one question that I should like to ask Dr. Spooner, that is, whether he has any notes showing whether the nurses who were attacked with typhoid fever were day or night nurses.

DR. SPOONER: No, I haven't any.

DR. STEVENS: I have been conected with the Cambridge Hospital for a great many years and we have found that nurses doing night duty have given us the greatest

number of our cases. In having a larger number of patients to care for they are not as careful about the bedpans, etc., and this explains a greater liability to contagion from the disease. This seems to me an important thing and emphasizes the necessity of nurses being warned of the danger they run in caring for these cases if they are not careful. The idea of inoculation is an entirely new one to me. I know very little about it, but it appeals to me and I think it is a thing of great importance. I believe it could be used in towns where epidemics exist to very great advantage.

Last year in the town of Madison, Maine, there was an epidemic of typhoid fever. This is a town of four thousand inhabitants. At the time of the breaking out of the fever the greater part of the people were using river water. There were about two hundred cases in all. In this section of the country typhoid fever was hardly ever known before. Other towns on the river below Madison where the river water was used had more or less cases but stringent measures were taken in the way of boiling water, and I believe this precaution prevented an epidemic in these towns.

MR. COFFEY. Mr. Chairman, a thought occured to me while listening to Dr. Richardson. Health officers of course are likely at any time to be brought up against such a case as New York has had,—a woman known as "Typhoid Mary," whom they have been obliged to quarantine and isolate on North Brothers Island for the past two years. Has this vaccine been tried upon these carrier cases anywhere with any effect?

DR. RICHARDSON. It has been tried in Germany, I think, once or twice, but the results have not been especially encouraging thus far.

DR. SPOONER. Mr. Chairman, I would say, in answering Dr. Stevens, that it is generally impossible to tell from the records what time a nurse has been on service, whether she has been a day or night nurse; but it is of interest to know that more cases are contracted by nurses in the female wards, where they have to attend to the bed pans and the urinals of the patients, than in the male wards, where such duties are carried out by the ward tenders.

DR. CHAPIN, (Providence.) This is a subject in which I am very much interested. Dr. Richardson's paper was particularly encouraging. We are all glad to hear the exact figures given, which show the success of this experiment in preventive inoculation. It was entirely new to me that there is prospect that the vaccine may be given by mouth. I think that if it should prove to be a successful method of administration it will be a very great help to health officers. Human beings are willing to take anything in the mouth, but they are very particular as to what is put under the skin, and I am sure that we could apply vaccine by mouth much more successfully than we could by means of a hypodermic needle.

Dr. Spooner called attention to a mode of infection in typhoid fever which has for some years seemed to me to be by all odds the most important mode of infection, that is, direct contact between the person who harbors the germs and the one who contracts the disease. I suppose that in all the cases he speaks of, the infection was transmitted in this way. We are, however, apt to consider other modes of infection as being far more important. There is much talk about infection by water, by milk, by oysters, and of late years of infection by means of flies. There is no doubt that these modes are important in some places, and at times they are of overwhelming importance, causing extension epidemics, but a large majority of communities have typhoid year after year without

having any great outbreaks. The important question is, how are these inter-epidemic cases of typhoid fever acquired?

I have recently attempted to analyze in a rough sort of way the source of the typhoid fever in Providence. During the last twenty-four years we have had about 4,200 cases of typhoid fever. About 340 of them, or 8 per cent. were due to infection of the public water supply. Perhaps an epidemic of about 80 cases in November and December 1895 was due to water, making in all 10 per cent. This of course, ought not to be allowed in any municipality, and I think we have done away with the danger of it in Providence by means of filtration. Ten per cent. then of our cases we may assume were due to infection of the public water supply. We have had a number of milk outbreaks in Providence, some nine outbreaks in the last 24 years, and the number of cases due to that cause is about the same as that due to water, about 340 or 8 per cent. I mistrust that this percentage is rather larger than occurs in most cities. Most of these milk outbreaks have been in the last two or three years. It may be that we may not have any more for several years, so that our percentage will be lower. I mistrust that probably throughout New England not over five per cent. of our cases of typhoid fever are due to infection by milk.

A great deal has been said about the relation of flies to typhoid fever, and it has been held by some that a large part of our typhoid fever is due to flies. In fact, some writers would lead one to think that the chief source of typhoid fever is the house fly. Let us examine the bearing of the Providence figures on this question. We have the autumnal increase in typhoid fever, just as we have in all cities. I find that with us the excess of autumnal typhoid fever over the rest of the year, running from the 1st of August up to December, is only about 25 per cent. of the total number of typhoid cases. If typhoid fever is due to

flies we must look for the cases attributable to flies in this 25 percent, but it seems to me unreasonable to assume that the whole of this 25 per cent. is due to the fly. Certainly a considerable amount of it is due to cases contracted outside of the city, or what is called vacation typhoid. We find in Providence that about 10 per cent. of all our cases are contracted outside of the city. Most of these occur during this period, so that our 25 per cent possibly due to flies, must be reduced by perhaps 5 per cent. But this 20 per cent. autumnal excess, as I told you, runs from August to December. We can hardly think that many cases of typhoid fever contracted after the first of November are due to flies, yet the large part of the excess is in November. If that excess is not due to flies why should we assume that all the rest of it is? I do not for a moment doubt that flies are a source of typhoid fever in military camps and similar places, where there are enormous swarms of flies and where there is a great carelessness in the disposal of excreta. They may under such circumstances be by far the most important source of typhoid fever. But in well sewered cities like Providence, Boston and Worcester, I doubt if they play a very important part in the spread of the disease.

This leaves us with the source of some 50 or 60 per cent. of our typhoid fever unexplained. What is it's cause? I believe it is due in the great majority of cases, to that form of infection which Dr. Spooner has told us about; to contact infection, by which is meant fairly direct contact with some person harboring the germs. A few years ago we would have considered this idea untenable, and we would have said, "Cases of typhoid fever are reported in this house and that house where there has been no typhoid fever, the patients have not in any way been exposed to a case of typhoid fever;" but now we know very well that they do not have to be exposed to a *case of sickness*, they may be exposed to a "carrier," a perfectly well person who

is harboring the germs of disease. The question of the greatest practical importance is how numerous are these chronic carriers of typhoid germs? It has been said by a number of German observers that probably three per cent. of the typhoid cases become chronic carriers. I am inclined to think that the number is considerably greater than that. I think so because so far as I can learn, though most of the reports are not very definite on that subject most of the searchers for the carriers have only made one, or perhaps two examinations of the faeces. Now it has been shown that a chronic carrier may go for weeks without showing any germs in the faeces, so that it is very easy to overlook such, in making a series of bacteriological examinations. But allowing that only 3 per cent. of the cases of typhoid fever become chronic carriers, the number must in the aggregate be very great.

If one turns to the last report of the census bureau on mortality statistics it will be found that in the registration area of the Unied States there were 12,000 deaths from typhoid fever in the year of 1907. The registration area includes about one half of the United States, the half with the least typhoid. 25,000 deaths from typhoid fever in the United States in one year! What is the fatality of this disease? Perhaps 10 per cent. I am inclined to think that it is really much less than that, but we will call it 10 per cent. How many cases do the 25,000 deaths represent? 250,000. Now 3 per cent. of that is 7,500 and we may be sure that this number of chronic carriers is added to the carrier population of the United States every year. Certainly there are a vast number of people who are foci of typhoid infection, and who unknown, are mingling freely with the public everywhere, and there is ample opportunity for them to spread the disease by contact, and to produce at least fifty per cent of the typhoid fever which is reported to us each year.

I cannot understand why the board of health of New

York City should isolate and virtually imprison "Typhoid Mary," and I cannot understand how the courts can support the procedure. If there are thousands, and there must be thousands and tens of thousands, of chronic carriers of typhoid fever in the United States today, it seems to me a great outrage to shut up the one particular woman that has had the misfortune to be discovered. The others we do not know about, or at least most of them we do not know about, and they are mingling freely with the public. Only a few of the carriers can possibly be discovered and if all could be discovered they could not possibly be isolated. The unknown carriers are the ones that are doing the harm. It can accomplish no good, and it is a great injustice, when we do discover a few, to attempt to isolate them for a life time, or to make them submit as an alternative, to an operation for the removal of the gall bladder.

THE PRESIDENT. I think the doctor is quite right, it does seem to me the most serious interference that has ever been attempted with personal liberty. I don't know but it is all right, but it is pretty serious business. Fortunately the Association has as its guest this afternoon a gentleman who comes from New York, and I think we will try to hold him to a certain amount of responsibility. Dr. Cole, we should like to hear what you have to say about all this.

DR. HILLS COLE, of New York. Mr. President, while a resident of New York City I am not a representative of the New York City Department of Health, but of the State Department of Health, so that I decline to be held responsible for the militant methods that the New York City Board of Health uses. Certainly we have the most autocratic government down there that I think is known probably in this country, or most anywhere. Talk about the militarism of Europe and Germany, I think that in the New York City Department of Health they exercise author-

ity in a way that is—well, I won't say unwarranted, but they certainly do do excellent work as a result of it. (Laughter.) Certainly if ever the result justified the means I think they are justified in New York City, because that is a community that we are very proud of and that we point to with a good deal of pride. In our New York State Department of Health we not not have much to do with our great big child in New York City. We think we are doing pretty well if we can get the other communities of the state to half way live up to the excellent work that is being done there.

The remarks of the first speaker about the incidence of typhoid in large hospitals is a somewhat new idea to me. I should very much like to see the reports of other institutions, to see if they run *pari passu* with it. I had hardly thought that in this day and age we could run across such statistics as those in hospitals which are supposed to be at the top notch of excellence.

As to the immunity coming from the typhoid injections, practically with vaccines, that is certainly a very interesting department, and I am with Dr. Chapin entirely in looking forward with hope to the question of the immunization by the mouth.

It undoubtedly is going to be of great help to public health workers if it ever becomes an established fact that we can produce immunization just as readily by taking the various vaccines by the mouth as by injecting them. It may be true of all types of vaccination, just as much smallpox as anything else. We have in New York State smallpox in our outlying districts, country districts, amongst the lumbermen in the north and amongst the negroes down in the Hudson valley, laboring in the brickyards,—and if we could only generalize vaccination still more than we do we should undoubtedly eradicate it. The great prejudice against it is this skin inoculation. If it is possible that we can get to a type of immunization by taking something by the

mouth, we shall certainly disarm a great part of the prejudice of the people. I believe they are working along that line amongst a certain section of the medical profession in Iowa. They are there attempting to immunize against smallpox by taking a preparation by the mouth, and I believe the Legislature there and the State Board of Health of Iowa have been obliged to rule that vaccination would cover immunization by taking by the mouth as well as by scarification.

DR. RICHARDSON. Mr. Chairman, I should like to say about immunization by the way of the mouth, that, as far as the present experiments go, such immunization is not so effective as that produced by the subcutaneous method. It is to be hoped, however, that future investigations will bring about an improvement in this respect. As I said, the United States Army authorities advocate this method, and Dr. Spooner has just received a request, he says, from the Marine Hospital to go over to Chelsea and immunize the hospital ward tenders, who will care for the large number of typhoids just received from the battleships. It is also said the Professor Barker of Johns Hopkins, just before he went to Europe this last summer, submitted to inoculation in view of the fact that he might possibly be exposed to infection while abroad.

DR. SWARTS. Mr. President, in connection with the statistics presented by Dr. Chapin there occurs to me a recent investigation made in the District of Columbia by the Public Health and Marine Hospital service, with its full corps of investigators and plenty of money to work with. They investigated the typhoid epidemics that they had had there, and they found that in 45 per cent. of them it was impossible to find any causation whatever, any association with infection in any way. The contacts were, I think, about 15 per cent., and the milk about 10. It really ap-

peared to throw discredit upon the water supply of the District of Columbia, or the city of Washington, although the water was thoroughly filtered. But considering the fact that they cannot find, with all their ability and all their investigation, the causation of this disease in 45 per cent. right in a district that they have full control of, I think we as health officers can feel contented if we do not find the causation in every case in every house we go to, although we are expected to do it, and a great deal more is expected of us, perhaps, by those who employ us.

DR. DURGIN. I have been asked to say something about the epidemic which occurred in Boston last year. I don't think there is very much to say of it apropos of the paper and the discussion, except that it added very largely to our percentage of cases which come from milk. We have had several small outbreaks in Boston in the last few years directly traced to milk. This one in particular gave us something more than 400 cases, and it occurred at the hands of two milkmen, one of whom handled the milk of the other as well as his own, while suffering from typhoid fever. It was one of those ambulating cases, and no one knew anything of its existence until he fell sick nearly two weeks after he became ill with the disease. This case was autopsied, and it was seen clearly how far back his disease began. In this instance the immunization, in question today, had it been known and endorsed, could have been utilized. One case was traced back to the 31st of March, and one case occurred on the 1st of April, two on the second, one on the 3rd and then it became violent with a large number each day. I would say that on the second of April we practically knew that the epidemic was due to milk, and on the third of April, the facts were sufficiently assured so that we could have utilized this immunization at once.

DR. PIERCE. You mean you could have vaccinated the takers of that milk?

DR. DURGIN. We could have given the immunization on April 3rd, within 24 hours after the first two or three cases occurred and were known to the Board of Health.

DR. DENNY. Following out Dr. Durgin's suggestion of giving immunizing doses to individuals who have been exposed, I should like to ask Dr. Richardson whether the inoculations would be of use after a person was already infected.

DR. RICHARDSON. I have had a small amount of experience in the treatment of typhoid fever with these same vaccines. This experience touches between thirty and forty cases. Some of these cases have been quite far advanced in the disease; others have been earlier. I could not come to any very definite conclusions except in this way. It seemed to me that cases which were taken early were favorably affected by the vaccine, whereas, if the disease were already very markedly advanced, the effect was not so marked, and this is what one would naturally expect under the circumstances. My feeling, therefore, would be that the effect of the vaccine would vary according to the time at which it was used. The earlier the inauguration of the treatment the more hope there would be of its having favorable effect.

DR. DENNY. Before the appearance of symptoms?

DR. RICHARDSON. Before the appearance of symptoms if possible. I have never had any such cases, but my feeling would be that inoculation in such cases would prevent the disease absolutely or it would be much milder.

MR. COFFEY. Where is this vaccine to be obtained? Is it a commercial product, on sale?

DR. RICHARDSON. The vaccines that we are using we make ourselves, but they can be procured from at least one of the large manufacturing druggists.

DR. HOLDEN. Mr. President, I had an experience some 20 years ago with an infection that is worthy of note. In a little village of perhaps 1,500 people we had a water infection. Nearly the whole village used the water supply. We found very soon that every case could be traced to individuals using the water either in their homes or where they were employed. We could definitely place the infection of the water supply at the first of March, because that was the first day in that village when from the thawing of the ice and snow water began to run. We could definitely place our first cases of infection at about the 10th of March. From the period beginning about the 10th of March to the middle of April, a very large number of the total cases occurred. Practically at this time the new cases, the original cases, ceased. In August we began to get what we called secondary cases, and I suppose they were from 30 to 40 in number. It has seemed to me in listening to this discussion that if there was danger from carriers we would have had in that little community a much larger number of cases. Personally I attributed the incidence of typhoid coming on in August and continuing for about six weeks or two months to the flies. I can't conceive how, if there are any considerable number of carriers, 3 per cent. as stated, and this number is increasing year by year, we would not soon be overwhelmed with typhoid fever.

DR. EMERSON. One thing ought to be considered in any case where there is an epidemic of typhoid, or where the disease is prevalent, in addition to the convalescent

cases which may be carriers. It seems to me there is an indeterminate amount of danger from persons who have not had the disease, but who may have been infected, and I think it has been proven that such persons may discharge the organisms in their feces, and if that is the case of course we have a very doubtful and indeterminate number of people who may be distributing the disease, and who may act as foci from which others may contract the disease. Of course if that is the case it might explain in part this large percentage of cases which we are unable to trace in almost all epidemics.

DR. BROUGH. Dr. Cole made the remark that in Iowa they regarded vaccination by the mouth as equivalent to vaccination by the arm. That method, in my opinion, is of no use. In this city at the time of an outbreak of smallpox that method was carried on at one of the hospitals here. There was one particular instance where the inoculation by the mouth was tried and proved to be absolutely inefficient. The patient contracted smallpox, and had a very severe case. Vaccination by the mouth was of no effect at all. I think that for any state to offer vaccination by the mouth as an equivalent to vaccination by the arm is entirely wrong, and I think it is not a scientific or a practical way of vaccinating.

As regards typhoid cases in the hospital, I had at one time to look up some statistics in the city, and I found that in almost all the hospitals in the city the nurses and ward masters were more susceptible to the disease than others in the community. Some of the hospital superintendents objected to having the fact brought out, or saying the disease was contracted in the hospital. They said the disease might have been contracted outside, because their hospital was very particular, the nurses were very particular in regard to their hands, and with a good corps of physicians, it was utterly impossible for them to get the disease in the

hospital. Nevertheless I think that it must have been contracted in the hospital, because it was prevalent in all hospitals,—there was no exceptions. At almost any of the large hospitals, especially where they have typhoid fever, you always find a certain number of the nurses, and occasionally some of the house physicians, though not often, and the ward masters, who get the disease.

If you can eliminate all danger from personal infection the dangers from the other sources will be very slight. Perhaps in the aggregate a larger number of cases are due to personal infection than are due to milk or water in the ordinary eastern cities, where they have good water supply. I think that that question of personal infection is the great one to be considered in almost all cases of typhoid.

DR. RICHARDSON. There is one point I should like to make in this connection, and that is that the incidence of typhoid in a hospital must not necessarily be taken as an indictment of the whole nursing staff, because the whole number of nurses may be at the mercy of some single individual who is careless. It is perfectly possible, for instance, that one nurse who is careless, may get some urine on her hands. She then takes the bed pan to the bathroom grasping the door knob with her unclean hands as she goes in. As a result everybody else who goes through that door becomes subject to infection.

DR. DENNY. Mr President, I think there is one other conclusion to be drawn from Dr. Spooner's paper, and that is the importance of segregating typhoid fever patients in a general hospital. Even if they are not put in separate wards, they may be grouped together on one side of a ward and put in the care of nurses who are attending only typhoid patients. If this were done fewer of these cases would arise. I think a nurse who is taking care of typhoid fever patients only would be much more particular than

where she has one typhoid patient and five or six other patients that are not typhoid. The segregation of typhoid patients is carried out in almost all the German hospitals.

DR. CHASE. Mr. Chairman, may I ask through you two questions of Dr. Richardson? One is, is the medical profession doing its full duty in its efforts to prevent the spread of typhoid, in the way of giving urotropin or some similar drug to convalescents from typhoid? And the other question is: I understand that the Health Department of Boston is going to examine bacteriologically the throats and noses of the children in four schools in the Brighton district during the summer, or early in September, to see how many of them are carriers of diphtheria. Would it be practicable to institute a somewhat similar examination where there is an outbreak of typhoid, and find out who is who in the matter of being carriers of typhoid? Would that be practicable?

DR. RICHARDSON. As regards urotropin, I cannot say, of course, how much this drug is used in private practice. As far as the Massachusetts General Hospital is concerned urotropin is given as routine throughout the disease, and I feel certain that its use has been the means of eliminating many of the urinary infections. As to the examination of a large number of people for the discovery of carriers, of course that is possible, but the examination of stools is not an easy matter, and it is something which should not be undertaken wholesale unless there is a very good reason for it. (Adjourned).

THE CONVEYANCE OF BACTERIA BY SEWER AIR.*

By PROF. C-E. A. WINSLOW
Mass. Institute of Technology, Boston, Mass.

In 1858, when the causes of epidemic disease were still shrouded in profound mystery, an able and distinguished English sanitarian, Charles Murchison, brought forward what he held to be conclusive evidence that typhoid fever was "produced by emanations from decaying organic matter." While this pythogenic theory of disease reigned it was natural that all sorts of deadly maladies should be supposed to spring from organic wastes, and to pass into the air with the odors of decay. Sewer gas in particular became an epitome of all unknown and subtle miasmatic influences. Twenty-five years ago such passages as the following abounded in medical and sanitary literature.

"If we look for the cause of the large mortality from zymotic diseases in our cities, we find it principally in sewer-gas poisoning. Other causes operate to swell the total, but to bad plumbing we may attribute the prevalence of pythogenic pneumonia, peritonitis, inflammatory rheumatism, typhoid and malarial fevers, croup, diphtheria, and many kindred diseases."

As the germ theory of disease was gradually established, —as it was proved that the contagious and infectious maladies were due to the presence of microscopic plant and animal parasites,—the case against sewer gas seemed less

*Read at the Oct., '08, meeting of the Mass. Association of Boards of Health. Withheld from publication until released by the National Association of Master Plumbers, for whom the work was done.

convincing. Organic emanations might favor the development of such diseases by lowering vital resistance; but they could not cause them. If sewer air were directly responsible for infectious disease, it could only be by the conveyance of living germs. Experimental bacteriology was therefore called in to determine whether this was possible and to what extent it actually occurred.

Nägeli and many other bacteriologists showed that under ordinary conditions germs adhere strongly to moist surfaces and are not easily given off from liquids into the adjacent air. On the other hand Sir Edward Frankland in England and Raphael Pumpelly and A. C. Abbott in this country carried out experiments which indicated that chemicals in solution and bacteria in suspension might be thrown into the air from liquids by the bursting of bubbles. On this contingency the possible danger of sewer gas infection rested; but it was still a question whether this danger was an important one. Actual examinations of the air in sewers by Miquel in France, Petri in Germany, and Carnelley and Haldane, Robertson and Laws and Andrewes in England showed that sewer air as a matter of fact contains very small numbers of bacteria and those of types common in street air rather than in sewage. Uffelmann found the same condition in the air of a house drainage system. Carnelley and Haldane and Laws and Andrewes isolated sewage bacteria in the immediate vicinity of points where active splashing occurred. As in the experimental studies of Frankland, Pumpelly and Abbott, there was clearly a possibility of air infection where spray was produced by some mechanical means. On the whole however the air of drains and sewers seemed to be of high bacterial purity, and all the observers who studied normal conditions in actual sewers concluded that the danger of bacterial infection from sewer air was remote.

These results, with the absence of any reliable evidence from the study of epidemics in favor of the transmission of germs by sewer air, have led sanitarians in Germany and

the United States to agree with practical unanimity that the danger of such transmission may be disregarded. In England, on the other hand, a large number, probably a majority, of sanitary experts have failed to be convinced, and have clung to the opinion that under some conditions the carriage of disease bacteria by sewer air is a practical possibility.

A little over a year ago, at the request of the National Association of Master Plumbers, I made some experiments on this problem, upon which no new investigations had been conducted for over ten years. I used an experimental stack of four-inch soil pipe, fifteen feet in height, with a running trap at the bottom and an exhaust fan, for drawing up a strong current of air, at the top. Sewage was placed in the trap, sealing it partially or completely, or resting in the bottom without sealing it. Air was drawn over the sewage and wetted surfaces of the pipe or was bubbled thru the sealed trap, and the air was examined at various points in the stack above. When the trap was partially sealed by pouring in a liter and a half of sewage and air was drawn thru the seal by a suction corresponding to an air flow of 620 feet per minute, the normal number of bacteria in the pipe (one or two per liter) was increased to 18 two feet above the trap, 14 seven feet above and 5 twelve feet above the trap. In another similar test sewage streptococci appeared at points, two feet and seventeen feet above the trap. Lower rates of suction, corresponding to an air flow of 490 feet per minute failed to show any increase in the bacterial content of the pipe air. When air was drawn at various rates over the surface of one liter of sewage in the (unsealed) trap no increase of bacteria could be demonstrated in the air. Finally in another series of tests the lower two and a half feet of the stack were thoroly wetted and air was drawn over this wetted surface. In one case, with an air current of 790 feet per minute, there was a slight increase in the bacterial contents of the pipe air (five bacteria per liter at a point twelve feet above). As a general result of these

investigations I reported to the Association of Master Plumbers that very strong currents of air could detach bacteria from sewage so as to cause an appreciable increase in the bacterial content of the air above, but that moderate currents, such as would be created under natural conditions, apparently failed to do so. Even under extreme conditions, the contamination of the drain air was slight. Only three of the characteristic bacteria of sewage were isolated from the air in the whole series of experiments. As a result of this investigation I concluded that the danger of bacterial infection from drain air was but slight.

At about the same time a series of experiments on sewer air was reported to the Royal Society of London by Major W. H. Horrocks of the English Army Medical Corps.* His results appeared at first sight to warrant widely different conclusions from those drawn by other observers; and it seemed necessary to re-examine the whole question with the greatest care.

Major Horrocks' general method consisted in the artificial infection of the lower part of natural and experimental drainage systems with a peculiar bacterium, the *Bacillus prodigiosus*, which is not normally found in the air. He then exposed small open dishes of nutritive media in the upper part of the systems; and among the colonies which developed on these plates he identified the particular form, *B. prodigiosus*, introduced in the liquid at the bottom. By this process he detected his test organism in a pipe 9 feet above an experimental running trap into which it had been introduced, and in the air of a catch basin of the town, into which he had poured it. Similar results were obtained when the lower sections of his experimental pipe system were wetted with a culture of the *B. prodigiosus* and then dried. The dried germs were apparently detached, carried up by the

*Proceedings of the Royal Society, Series B, LXXIX., No. B 531, p. 255.

air and deposited on the plates above. In another series of experiments sewage infected with the typhoid bacillus or with *B. prodigiosus* was allowed to flow, quietly and without splashing, thru a horizontal pipe to which a vertical pipe was connected at an intermediate point. Plates exposed in the vertical pipe showed colonies of the specific bacteria introduced even at a height of eleven feet and nine inches above the liquid. Emulsions of *B. prodigiosus* were flushed from the closets of drainage systems in actual use and the germs thus introduced were found in all parts of the systems in open connection therewith, even at a height of fifty feet above the traps. Major Horrocks, by the same method of exposing Petri plates, found *Bacillus coli*, the characteristic organism of sewage, in a house drain and in the main sewer of the town. Finally he passed the feces of a typhoid patient suspended in water thru a half-S trap and found the typhoid organism on plates in a vertical pipe above at a height of three feet six inches from the liquid.

Major Horrocks' report, coming from an authority of such eminence, naturally excited the deepest interest among sanitarians. In many quarters the old suspicions of sewer air were revived with almost their full force. The Journal of the American Medical Association, for example, said in commenting upon Horrocks' work, "The sewer peril therefore still exists, and disconnecting traps are sanitary necessities. It is possible that we may still have to look to sewer emanations as the occasional cause of mysterious outbreaks of disease. Air-borne typhoid is a reality under other conditions, and apparently we shall have to recognize a possibility, tho perhaps a remote one, of its conveyance by the old-fashioned sewer gas."

In the Illinois State Board of Health Bulletin for May-June, 1907, the results of Major Horrocks were cited in defense of the statement made in a previous bulletin that "There is no doubt, also, that sewer gas is a carrier of diphtheretic poison, and that many outbreaks hence hold close

relationship with defective drainage, sewers and cesspools," a statement which was made the subject of just editorial criticism in the Journal of this Association for February and August, 1907.

Other sanitarians, including those of the highest competency, maintained a more conservative attitude, and awaited further evidence before abandoning the conclusions indicated by that previously accumulated. The matter stood about as follows. On the one hand Horrocks had shown that specific bacteria, present in traps and drains, could get into the air above by splashing, by the bursting of bubbles and even in some experiments from the surface of liquids apparently in quiet motion; he detected such bacteria by the plate method in the air of ventilating pipes at considerable distances (once at fifty feet) above the infected liquid. On the other hand, Miquel, Petri, Uffelmann, Carnelley and Haldane, Laws and Andrewes and others had shown that the number of bacteria present in the air of sewers and house drains is extremely small, and that those present are generally air forms and not sewage forms. Furthermore reliable evidence of the spread of infectious disease by sewer air is wholly lacking. The inconsistency of the two sorts of evidence required explanation; and after presenting the facts to the Sanitary Committee of the National Association of Master Plumbers, I was commissioned by them to attempt the clearing up of the apparent contradiction.

I first attemped to repeat Major Horrocks' own experiments as closely as possible. I examined the air of a boat chamber on one of the main sewers of the City of Boston, as Horrocks had done in the sewers of Gibraltar. I found colon bacilli on my plates in many experiments; but their number was small near the sewage, greater near the street, and greatest in the street air itself. It was clear that they came from street dust infected by horse dung, etc., and not from the sewage at all. I then constructed an experimental pipe system, such as Horrocks used, consisting of a half-S

trap of 6 inch tile drain to which an eight foot vertical stack of the same pipe was connected. A rich emulsion of *B. prodigiosus* culture or of *B. coli* culture or of feces in soapy water was poured thru the trap and Petri dishes of nutrient gelatin or agar were suspended at various points in the pipe above. Control plates were also exposed at various points (nine in all) in the laboratory outside; none of these control plates ever showed the specific organisms. Two tests with feces failed to show *B. coli* in the pipe, and three tests with an emulsion of *B coli* also gave negative results. In two other tests *B. coli* colonies appeared on the plates; in one case three colonies two feet above the liquid, two colonies four feet above and one colony eight feet above; in the other case, five colonies two feet above, two colonies four feet above and a single colony six feet above. Six tests were made with *B. prodigiosus.* Three were negative. In one case a single colony appeared two feet above, and another six feet above. In a second case three colonies appeared two feet above and one eight feet above. In the third case there were six colonies two feet above, three four feet above, one six feet above and one eight feet above. Altogether six out of 28 plates exposed in the pipe above emulsions of *B. coli* or feces showed colonies of this germ, eight colonies at two feet, four at four feet and one each at six and eight feet. Eight out of 24 plates exposed in the pipe over the *B. prodigiosus* emulsion showed the specific organism, ten colonies at two feet three at four feet, two each at six and eight feet.

Granting that bacteria may be discharged from the surface of a foaming liquid into the air above, it seemed *à priori* probable that even slight currents would transport them to considerable distances. It is clear that bacteria should be carried upward thru a pipe by a current of velocity just exceeding the rate at which they would fall in quiet air. The falling of small bodies takes place according to a physical formula, known as Stokes' law which for a sphere of radius

.0001 cm and a density near one gives a rate of .012 cm per second or 17 inches per hour. Theoretically bacteria should fall in quiet air at about this rate and should be transported by currents in excess of it. I made a few tests of this point by spraying cultures of *B. prodigiosus* into a chamber with an atomizer and drawing air over into a culture bottle thru a tube of known diameter and at a known rate. The slowest currents tested (72 inches per hour), carried the bacteria over in large numbers.

The general result of the experiments, so far, was to confirm the main contention of Major Horrocks,—that specific bacteria may be ejected from a foaming soapy sewage into the air above, and once in the air may be carried to considerable distances. The proportion of positiv results obtained was small however. With an exposure of two hours over a soapy liquid richly inoculated with artificial cultures, a total of 31 specific bacteria were isolated from 52 plates. The question at once suggested itself whether the whole question at issue might not be a quantitative one. Horrocks, by exposing plates over infected sewage found that some of the bacteria present could be isolated from the air. Other observers who had examined sewer and drain air under natural conditions by quantitativ methods had failed to find sewage bacteria in appreciable numbers. It might be possible that a few bacteria do get into the air above foaming sewage; but that their number is so small as not to affect the bacterial content of the air as a whole, as determined by ordinary quantitativ methods.

I next therefor attempted to investigate the question from this standpoint; and made first a careful examination of the best available quantitativ methods. Horrocks' procedure of exposing open dishes of nutrient media to the air is of course not quantitativ at all, since the bacteria which happen to fall on the plate are not related to any particular volume of air. The method adopted by most recent observers, and the one which I used in my first experiments in-

volves the straining out of the bacteria in the air by drawing it thru a sand filter. The bacteria are then washed out from the sand in steril water and enumerated by the ordinary cultivation methods. During my work this year I developed a new method* in which a measured volume of air is drawn into two large Culture Bottles and the bacteria are allowed to settle out and form colonies on nutrient media in the bottom of the bottles. This method, altho cumbrous, avoids all danger of losing bacteria by drawing them thru the sand and was used in all my later work. A careful series of comparativ tests showed however that the error involved in the sand method used in other investigations is not serious, and the earlier results may be accepted as correct in their general conclusions.

By the use of the Culture Bottle Method I attempted to control Major Horrocks' results from the quantitativ standpoint. I prepared a rich emultion of *B. prodigiosus*, containing hundreds of millions of bacteria per liter, (230 million to 5 billion), made it foam freely by beating it up with soap, and poured it into a large glass bottle or into an open dish. The air in the bottle or the air of the laboratory over the open dish, at a height of 1-3 cm from the foam, was examined by the Culture Bottle Method. Out of thirty liters of air examined, five only contained *B. prodigiosus*. In one liter three were found, and in the other four, one each. Clearly the bacterial infection of the air produced by very vigorous foaming was but slight.

In these experiments there was little splashing of the infected liquids; the bursting of bubbles from the foaming surface was the only source of air infection. I next imitated natural conditions more closely. Thru the kindness of Mr. Craig, Chairman of the Sanitary Committee of the Association of Master Plumbers, I had an ordinary porcelain water closet bowl set directly on a four inch cast iron S-trap,

*Described in Science, N. S., XXVIII., 28, July 3, 1908.

having a clean out hole at the crown. The S-trap was connected at its lower end with an ordinary four-inch running trap. A rich soapy emulsion of *B. prodigiosus* was poured rapidly into the water closet bowl so as to rush down thru the two traps, foaming and splashing as it went. Samples of air were collected from the clean out at the crown of the upper trap and from the upper opening of the lower running trap, a few inches only from the foaming surface of the liquid which contained from 300 million to 5 billion bacteria per liter. Everything was as favorable as possible for the discharge of bacteria into the air. Yet, out of 44 liters of air examined, 43 contained no *B. prodigiosus*. One liter showed a group of eleven colonies apparently derived from a single infected droplet. It must be remembered that in all these experiments I used liquids artificially infected with large numbers of specific bacteria and caused to foam by beating them up with a considerable addition of soap. Vigorous splashing was added to the foaming in the last series of tests. Under these extreme conditions, as in Major Horrocks' experiments, the specific bacteria present could indeed be detected in the air; but the actual number present even here was extremely small.

These experiments seemed to offer a reasonable explanation of the difference between Major Horrocks' results and those of other observers. Bacterial infection of the air from foaming liquids may take place. Horrocks, using, for the most part, artificially prepared emulsions and ignoring the quantitativ aspect of the case, naturally obtained positiv results. When the question is approached numerically however the amount of air infection, even under extreme conditions, is so slight that one would scarcely expect the general air of sewers and house drains to be appreciably affected under normal conditions.

The final test of experimental conclusions of this sort must always be made by an appeal to existing conditions under normal circumstances of actual use. The numerous

investigations cited above have shown that the air of the street sewers is singularily free from bacteria. The air of house drainage systems might however be supposed to be worse than that of the street sewers; and with regard to their bacterial condition only the single report of Uffelmann appeared to be available. As a crucial test, I therefor determined to carry out a sufficient number of examinations of house drain air to gain a fair idea of its bacterial composition. With the cordial co-operation of Mr. Craig, I have been able to complete this work and to obtain results which seem to me conclusive.

I studied nineteen different plumbing systems, five in buildings of the Massachusetts Institute of Technology, four in the wards of the Boston City Hospital (thanks to Dr. McCollom), three in tenement houses in East Boston, two at City Hall (thru the courtesy of Dr. Durgin), two at the Hotel Lenox and one each in the Ames Building, in the Technology Club, and in a private residence on Newbury Street. The plumbing pipes were tapped at various representative points, selected to give as wide a range of conditions as possible. Twenty places in all were examined, two in one of the tenements and one on each of the other systems. Of the twenty points, five were on main stacks of vertical soil pipe in the lower stories of the respective buildings, seven were on extensions of vertical stacks, just above the roof, two were on horizontal house drains, three were on branch wastes, two at clean outs and one on a ventpipe at some distance from the main stack.

From each of these twenty places, ten one-liter samples of air were drawn off into Culture Bottles, the taking of the ten samples being distributed over a period of about two hours.

The method of collection was as follows: Short pieces of glass tubing were prepared with a bulb about one inch in diameter blown in the middle of each. One end of this tube was inserted into a perforated rubber stopper which just

fitted the three-quarter inch hole drilled in the plumbing pipe, and the other end was connected to the first of two Culture Bottles. Air was slowly drawn thru bulb and Culture Bottles by water suction. If liquid passed over into the tube by capillarity from the inner walls of the plumbing pipe it collected in the bulb and the Culture Bottles were protected from direct liquid contamination. In three cases however even this precaution was unavailing; the bulb overflowed and spoiled the test.

The Culture Bottles into which the samples were drawn contained dextrose broth. After sampling, they were incubated at 37° for three days and as soon as growth appeared subcultures were made on litmus-lactose-agar, for the isolation of the characteristic sewage organisms, *B. coli* and the sewage streptococcus.

In all, 200 liter samples of air were examined. Three of these samples were lost from the fact that the sewage in the plumbing pipe ran into the collecting tube and over into the Culture Bottle, directly contaminating it with liquid. There remained then 197 tests. Of these only 48 contained any organisms capable of development at 37°; and only four contained sewage organisms. The colon bacillus was found three times, and the streptococcus once. In every one of these four cases there was a discharge of sewage in the pipe at the point of examination, and at the moment the sample was taken, so that spray was actually splashing in the air. The first case was on the plumbing system in Wards W and X of the City Hospital. Here samples were taken from a sink drain and at the moments when two of the samples were taken the sink above flushed out and liquid passed over into the bulb between pipe and bottle. In one of the cases *B. coli* was found in the Culture Bottle. The second case was in the Nurses' Home of the City Hospital. Here samples were taken from the main stack. Leaking valves above produced a steady flow down the pipe and there were frequent flushes. Water collected in the bulb in every case

but two; and in one case the sewage streptococcus appeared in the bottles. The other two positiv cases were in one of the E. Boston tenements. Here the air sample was drawn from the main horizontal house drain about ten inches from the foot of a vertical soil pipe. While three of the samples were being taken there were flushes in the soil pipe and much splashing at its base in the house drain. In two of the three cases *B. coli* was isolated from the Culture Bottle. In every one of these four instances samples of air, collected from the same point ten minutes later contained no sewage forms, showing that the contamination was only transient. In the other 193 cases of the 197 no sewage bacteria were present. In not a single case out of the 200 were sewage bacteria found in a liter of house drain air, unless there was mechanical splashing at the point, and at the moment, of examination.

To sum up; my experiments confirm the results of Horrocks in so far as they show that specific bacteria may be ejected from liquids into the air above. My tests of house drain air, like those of Carnelley and Haldane and Laws and Andrewes on sewer air, indicate that mechanical splashing may produce a local infection of the air in immediate contact with the spray. Such an infection does not however extend for any distance or persist for more than a minute or so. I found the general air of house drainage systems singularly free from bacterial life. Out of 200 liters examined, 152 contained no organisms capable of development at 37°. Sewage bacteria were found in the air of the house drains only four times out of 200 liters and then in the presence of mechanical spraying of sewage at the point of collection. The general air of the house drainage systems, aside from this local infection, was, as far as examined, free from sewage organisms. These results accord well with those obtained by Miquel, Petri, Carnelley and Haldane and Laws and Andrewes in street sewers, and with those reported by Uffelmann for drain air.

On the other hand stands the work of Major Horrocks; and very recently his results have been confirmed by another observer whose authority is of the greatest weight. After this communication was prepared I received the latest report of the British Local Government Board and found that it contained a paper by Dr. F . W. Andrewes on the micro-organisms in sewer air.* Dr. Andrewes, who obtained generally negative results when working with Mr. J. Parry Laws in 1894 has now been able to demonstrate that "under certain circumstances, at all events, sewage gives up its bacteria to sewer and drain air." By exposing a large series of plates in a sewer at Hampstead and in a drain of St. Bartholomew's Hospital, London, he isolated 19 strains of streptococci and 42 strains of organisms of the colon group. The most interesting part of this investigation is that Dr. Andrewes was able to show by the use of Gordon's fermentation tests, and by the admirable scheme of classification which he himself, with Dr. T. J. Horder have worked out for the streptococci, that the streptococci present were forms characteristic of sewage but rare in the intestines of the Herbivora and generally absent from street air. The bacilli of the colon group were also studied in detail and proved to be characteristic sewage organisms. Finally Dr. Andrewes repeated in two experiments the demonstration of Major Horrocks that B. *prodigiosus* can be isolated from the air of a house drainage system after a culture of the organism has been flushed from the watercloset.

Rightly interpreted, there is no necessary conflict between the experiments of Horrocks and Andrewes and the general consensus of earlier workers Horrocks and Andrewes have shown that bacteria are discharged into the air from foaming and splashing sewage. They have made no estimate of the extent of the air pollution which results. Their method

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*Thirty-sixth Annual Report of the Local Government Board; Supplement containing the Report of the Medical Officers for 1906-7.

of exposing plates is an extremely delicate one, but it has no numerical significance. Andrewes estimates that the exposure of one plate for an hour yields as many colonies as the examination of several hundred liters of air. Sanitation in order to be intelligent must however be quantitativ. It should deal, not with theoretical possibilities but with practical probabilities,—measured as closely as possible in regard to their quantitativ importance. I have shown in my experiments that even under the most extreme conditions the number of bacteria which get into the air from an infected liquid is small. I have found by the examination of a series of plumbing systems in actual use that intestinal bacteria could only be isolated four times out of 200 liters, and then only at points of direct local infection from splashing. These results, while they do not contradict the experiments of Horrocks and Andrewes, do explain the apparently inconsistent reports of other investigators. Bacteria do get from sewage into sewer air; but they get there in such small numbers as scarcely to affect its general composition.

In a surface water of fair quality, like that of New York City, the colon bacillus can almost invariably be isolated from ten cubic centimeters. This means a slight degree of intestinal pollution but experience has shown that the chance of infection from such a water is but slight; and we drink it without serious alarm. If one were to breathe for 24 hours the undiluted air of a house drainage system, at any point not immediately infected by mechanical splashing, it appears that less than fifty intestinal bacteria would be taken in; for the daily consumption of air is about 10,000 liters and in 193 liters I obtained negative results from air of this sort. In drinking New York water, twice as many colon bacilli are ingested every day, for 1000 cubic centimeters is a small amount for daily consumption. So there would be less danger of contracting disease from continuously breathing the air of a vent pipe or of a soil pipe, above where liquid is splashing, than from drinking New York water.

There is a possibility of course that the gaseous emanations from decomposing organic matter may exert a predisposing influence which makes the body succumb more easily to specific germs, introduced in other ways. Many have held that in this way sewer gas might indirectly promote disease. This view, supported mainly by the experiments of Alessi, well deserves further study; but I have not dealt with it in the present investigation. I believe that my results, in the light of all previous evidence, warrant the conclusion that the chance of direct bacterial infection thru the air of drains and sewers is extremely slight.

DISCUSSION.

VICE-PRES. DURGIN. While we have listened to the scientific side of this important question we are honored this afternoon with a gentleman who not only possesses the scientific side but the practical. I have the pleasure of introducing Mr. David Craig, who will open the discussion.

MR. CRAIG. At this time it is proper that a word be said, defining if possible the necessary position that the plumber would occupy in view of the facts disclosed by the preceding paper, and the results noted in the work of the National Association of Master Plumbers, through its Sanitary Committee during the past two years. It has been the aim of the committee to get at the facts about sewer air and its relation to the public health whether or no it was a medium of infection through its carriage of the germs of disease. Professor Winslow has very ably placed the matter in its proper light, and while his findings are astounding and mark an epoch in the study of sewer air, it is not apparent that we should broadly modify plumbing practice without due consideration to many other very essential matters connected therewith. The establishing of the exact status of sewer air does not exclude the use of a trap under the plumbing fixtures, as some investigators have suggested, inasmuch as sewer air is harmless as a medium of communicating germs. It is nevertheless poisonous and we must be guarded that "the pendulum does not swing the other way unreasonably" to use the words of Prof. Winslow. Along with the investigation of sewer air the National Association of Master Plumbers has through its Sanitary Committee investigated fully the comparative resistance to syphonage of the water seal of traps used in plumbing for the trapping of fixtures. The results are quite as marked and startling as those noted in the matter of sewer air, and lead me to say that the trap vent-pipe as installed today in our city is a very poor assurance of safety to the trap seal. This phase

of the National Plumbers Sanitary Committee's works, viz., the testing of traps is treated fully and at length in their report the results being tabulated and illustrated.

It is in view of these last facts and results that modification should be had in the installing of plumbing and in plumbing practice. It might be said and expected that these results should be the basis of an intelligent revision with added investigation into many lines which broaden away from the basic facts. The substantial modifying of the present method and material of trap venting not only looks toward a lower first cost, but also toward a benefit to building construction itself through the absence of the cutting of timbers, etc.

It will lower first cost; but unfortunately this is not realized at present, due to the double reason that municipal building departments have placed their approval on some forms of anti-syphon traps and ignored others, with the consequent stiffening in the price of the preferred trap; the price being such that the money saved by the omission of the trap vent pipe is paid in the purchase of the preferred trap.

This must be changed if the building public are to enjoy anything of the results suggested by the work of the National Plumbers Society committee and Prof. Winslow. In the past the plumber but repeated what was told him by the sanitary engineer, and has not been slow to enlarge upon it, earnestly thinking that he was in the right direction. Having naturally observed cause and effect in many directions he has materially built up a fabric which he sincerely thinks is essential to a proper state of the public health. Much might here be said of the hysteria of plumbing legislation throughout its whole effort to date, but that is another story.

This can be said,—that it will be difficult to wear down the opinion created and established by years of plumbing ordinances and laws which at this writing are backed up and

entrenched by the "Bureaucracy of Administration" called into being through their agency.

While I have not at this time any official word from the plumber to you, yet as an observer and student of the whole matter I can say this for my craft,—that they desire to know the truth at any cost, and having ascertained it as good citizens and conscientious craftmen they will not be found opposing proper changes along new lines of practice.

MR. WESTON. Unfortunately I was not present at the beginning of the meeting and have not the whole paper in mind, so that I can discuss it intelligently. What I heard was very instructive, very much in accordance with what we hoped would be true when Professor Winslow finished his work, and I congratulate him upon the important results obtained. It is unfortunate that in most of our city plumbing work the expression of what constitutes good plumbing and bad plumbing in the ordinances of different cities varies so much, so much so that what is recommended in one city very often is forbidden in another. It seems to me that the aim of all plumbing work, especially in the light of facts which Professor Winslow has brought forward, should tend toward simplicity. We should try to eliminate every bend, every unusual device, everything on the inside of the pipe which will interfere with the passage of the liquid from the fixture to the sewer. It seems to me that the best form of drain for a house is the one which offers the freest opening from fixture to sewer, and the more air you can pass from the street sewer backward through the house up to the outside air the better.

In many of our old houses here in Boston, there are old waterclosets and wash bowls and tubs which, even though they may not have a bad effect upon the public health, do cause a great deal of inconvenience and repulsion because of the odors which come from them, odors from decomposing waste upon the the inner walls of the pipes. It is especially

true, I think, of waterclosets and basin overflows. This brings up the question of the seat vent in waterclosets. It seems to me that it has been a very good device for the prevention of odor. It is not required in Boston; it is in some smaller cities of the state. It seems to me that anything in our plumbing practice which would remove the possibility of any odor from the system, and would make it simple and clean, would accomplish all that sanitarians would demand.

MR. CRAIG. In regard to the first proposition, the omission of the running trap, I am, and we are all, rather agreeable to the omission of anything that looks like an obstruction in the drain. If you will believe me, gentlemen, all those things which tend towards the obstructions that do obtain in the drain are not the suggestion of the plumber. A plumber never invented the modern watercloset. I had occasion to know that through a patent suit which was determined some two or three years ago, as, having been connected and acquainted with the early history of that patent, I was a witness for the plaintiff, and in the research, going back as far as 1870, there was not one of those patents ever granted to a plumber. The plumber's practice is opposed to bends. He is taught that from his youth. When our inventive genius from some other sphere of life suggested the wriggley outlet of the watercloset, the plumber thought that a poor thing.

Just a word in regard to the running trap. I agree with that. We had some discussion about it some eight or ten years ago, and as a result believed that in a new section, where the sewer was being laid anew and the buildings were all new and of a residential character, it might be a very nice thing for that sort of condition to obtain. Right on the heel of that investigation I was called into a building down town with a twelve-inch sewer coming into it, and about four inches of water pressure on it from steam in the main sewer. The joint surrounding the main drain, a twelve-inch

joint, had been blown right out, and if that main trap had not been there every joint up to the roof of that building would have been loose. Is it a fact or not, if you could by an ordinance leave out the running trap and that condition obtained, that the city would be liable for damages? Isn't it possible that it is so? In the older parts of the city we have thought of it in that way, that there should be a protection against the blowing off of the steampipe of your neighbor's boilers, or whatever they are, because after all the ordinances that will be made, and all the talk about the tubes or pipes to condense and that sort of thing, you understand that that won't save the matter of blowing out the boilers into the sewer. That is just one condition that crystallized a great many of our opinions toward the retaining of the running trap during this last modification of the city ordinance,—that alone,—and it is the most valid objection that I know of that has been made. Of course we have heard of it freezing from the down draft due to the fresh air inlet, and we have read the figures of the ventilating opportunities that it has, how many cubic feet it will discharge, etc., and we have weighed them all and given them all proper value. But we do say that, with the present method of pipe joining, if you allow an opportunity for those joints to become loose through the omission of the running trap you are doing something that should not be allowed.

MR. WESTON. I hope that I did not make myself misunderstood as advocating an abolition of all traps in sewerage systems, regardless of conditions. I did want to say that I believe that our aim should be the abolition of those things as far as possible. It is impossible, of course, in old plumbing systems to apply the same rules that one can in new. I have had a fairly intimate connection with two or three cities which have started anew on their sewerage systems and have applied the newer principle with great success, but I know that in the old towns of England such a

procedure would be almost suicidal. Great progress could be made if we could prevent discharge of steam into sewers, and I think some ordinance to prevent the steam going into sewers directly would be far more economical than to make the putting in of running traps necessary throughout the whole system. Neither should one forget that boiling hot water is nearly as bad as live steam.

PROF. SEDGWICK. I would like to say just a word in recognition of the unusual character of this research of Professor Winslow's at the instigation of the Association of Master Plumbers. We hear a great deal of talk now-a-days about craftsmen and trades unions and the like. We hear a great many unpleasant things said. Some of them I think ought to be said and must be said. But when we get a chance to say what we may now say, that here is an association of craftsmen which has undertaken to go into a matter of public importance in a scientific way, to spend money to get accurate results, and then stands ready also to govern its action by those results, we have one of the most hopeful signs of the times.

All through this work I have myself as an onlooker taken the greatest interest in it, because it seemed to me that it was an inspiring feature, a hopeful note of the times, that the National Association of Master Plumbers should have, to begin with, a sanitary committee at all; that it should set that committee to work and put the work in good hands; that its committee should seek out scientific aid; that it should stand ready to accept the results, whatever they might be, and to govern itself accordingly. That is an attitude which can only command the respect and the regard of every American citizen, and I think that we ought to feel very grateful to the Association and to the spirit of the times that things are working in so auspicious a direction.

As for the results, those of us that are as old as I am must look at them with mixed feelings. Some of us were brought

up to think that sewer gas was the very devil, and that those people who had any pipe coming into a bedroom, or even into a house, were in grave danger of their lives. If a case of typhoid fever broke out in a family almost the first thing that the doctor did was to run to the basement and see if there was a broken pipe, and, as there generally was, he usually came to the conclusion that it was the sewer gas which had caused the disease. He never thought of looking at the milk pail, or at the school, or at other vehicles of infection; sewer gas was everything. Then a few of us who tried to keep a level head said, "If that is the case, it is rather odd that sewer air is so free from germs, and that men who work in sewers are so uniformly healthy and strong." And so we became sceptical on the matter, and pushed the pendulum over to the other side and said "Sewer gas undoubtedly may be sometimes a poisonous gas, but that it carries disease germs, which have not got wings to enable them to fly on the gentle breezes which it makes, is an idea that we cannot entertain." And now come the experiments of Major Horrocks, who says that after all such gas does contain germs, and then come, fortunately at the very same time, the explanatory researches of Professor Winslow. This is the second time that Professor Winslow by applying the quantitative method has reached what I believe to be the truth. The first time was in the ice problem. People were saying that ice was bad, because if you froze up typhoid fever germs in ice and then examined a particle of that ice, made a culture of it, you could still get typhoid germs. That was true, but they forgot to count the number that they froze up and the number that they got out after freezing. When Professor Winslow did that he found that 99.9 per cent. had died in the freezing, and although there were still a very few left, one here and one there and one over yonder, yet to say that ice was as dangerous as the water from which it came, or anything approaching that, was simply absurd. His results have stood firm until this day, although it is several

years ago that they were made. And now for the second time, applying the quantitative ideas to qualitative work, the qualitative work of others, I believe that he has reached the same correct conclusion.

DR. CHAPIN. May I have just one minute to say that this is the finest work that has been done and the finest paper that I have heard for many a day? (Applause.) I think this Association is to be congratulated that we are permitted to hear it and have it appear in our Journal. The problem itself is certainly an important one; but there is something as Professor Sedgwick has just suggested still more important than its solution. The solution of this problem has enabled Professor Winslow to emphasize, more than has ever been emphasized before, the fact that in all studies of infection we must make the study a quantitative one.

MR. RICKARDS. Mr. President, having some time ago been rather innocently drawn into a controversy on this subject, I have listened with the greatest of interest to Professor Winslow's exhaustive paper, have been pleased to see the quantitative factor brought out so fully. If we take for an example, a case of typhoid fever in a house where the dejecta from the patient is emptied down the closet without the use of disinfectants, we have a possible chance of infection, but from a mathematical standpoint how much chance is there that any of the typhoid bacilli will find the alimentary tract of any other person living in that house? May we not conclude from this paper that the attention of public hygienists may more profitably be put upon other sources of infection?

Our present plumbing ordinances need revision. Some of them unless liberally interpreted are capable of working great injustice. To illustrate, some time ago in planning a laboratory we found that according to the plumbing laws of the city of Boston each and every small sink, (9x12 inches),

of which we had twelve, would have to have a trap and a vent, which would mean if the law had been insisted upon in our case that all over a large microscope room we would have had a system of vent pipes and traps which would have made our laboratory look like a factory at best. Fancy the result! It might be added that a liberal interpretation has worked no harm to any one. Perhaps thru the Sanitary Committee of the National Plumbers Association we may look for assistance.

PROFESSOR WINSLOW. Mr Chairman, I have intended for some time to write a magazine article on the subject of commonsense in sanitation. As long as you have called on me again, and as I perhaps never shall write the article, I will give the idea away now for what it is worth.

As I look at it, we have a certain amount of energy and money to spend in protecting the public health. That energy seems likely to be greatly increased in the near future. Sanitary science, the public health, are phrases to conjure with. We have a large national organization, under the guidance of distinguished political economists, devoted to stirring up this sentiment and increasing the amount of energy and money that can be devoted to the public health. I think, ladies and gentlemen, it is time that the sanitarians of this country saw to it that that energy and money is wisely used. I have no doubt that there are numerous ways in which some good may be accomplished, some disease may be prevented, but we all know as sanitarians that in certain directions a given amount of money and energy can do a certain amount of good, that $100 or $1,000 will save so many lives, and that in other ways that amount of money, if you spent it every year, would not save a life in a century. There are certain means of spreading contagious disease which are known, and whose prevention is known, and it is very essential that our energy should be devoted to those

and not squandered on things which are only theoretical and possible and of minute importance.

I hope very much that in some way the members of this Association and of other associations made up mainly of professional hygienists should prepare—I don't think anything can be done at the present moment, but they should prepare—to assert themselves on this matter, to have it understood that there is a real science of sanitation. Sanitary reform is not a matter which can safely be left to medical men, as such, unless they are trained sanitarians, and it certainly cannot be left to those who are entirely laymen as far as sanitary science goes. We want to see that what energies we have are devoted to those diseases which can be prevented, and can be prevented at the minimum expense. Let us do away with those first. Let us do away with typhoid fever from infected water, and with typhoid fever and scarlet fever and children's diseases from infected and dirty milk. Let us devote as much of our attention as we can to a few of these simple things. Then, after they are wiped out, after we have got the maximum interest on our money and our effort, we can go on to minor things, like ice, and sewer air, and various possible and theoretical dangers.

PERSONAL HYGIENE.

By PERCY G. STILES, Ph.D.
Instructor in Physiology, Massachusetts Institute of Technology

OXYGEN AS A STIMULANT. When Joseph Priestley inhaled some oxygen which he had prepared, he fancied that the effect was slightly exhilarating, and suggested that the use of the gas might sometime become a popular indulgence. We have lately heard of its use to fortify exhausted pugilists. English observers* have shown that runners may slightly lower their records for middle distances (half-mile) by the preliminary breathing of oxygen. In these trials the lessening of distress has been more striking than the gain in speed. Dr. W. G. Anderson† has published a valuable address upon this matter. He has recently found that oxygen is of marked assistance in relieving the dyspnoea and the malaise experienced by mountain-climbers. A new generator of a compact and portable type was taken by him upon expeditions to two Mexican peaks, over 17,000 feet high, and the use of the gas was of the greatest benefit.

These demonstrations make it appear that the common teaching of Physiologies about oxygen needs some modification. It has been usual to say that the normal individual is not effected by the substitution of oxygen for ordinary air, because the blood corpuscles saturate themselves at a low pressure of the gas and also because the tissues are

*Flack and Hill, Journal of Physiology, 1908, XXXVII., p. 77.
†American Physical Education Review, 1909, XIV., p. 277.

constantly offered more oxygen than they will use. It has been recognized, of course, that in pulmonary disease oxygen may be breathed in place of air with advantage, indeed often in the saving of life. Briefly stated, the doctrine has been that oxygen may be efficacious when obstructions hinder the arterialization of blood in the lungs, but that it is superfluous when such obstructions do not exist.

It has been shown that blood takes up nearly as much oxygen from a mixture containing 10 per cent. of the gas as from pure oxygen. Hence it has been argued that raising the proportion of oxygen in the alveolar air cannot be of any service, unless the existing percentage is abnormally low, as it is likely to be in pneumonia. During muscular exercise we know that the alveolar air is quite as rich in oxygen as during rest, the breathing fully keeping pace with the exchange. Quite plausibly, then, one may contend that nothing is gained by running up the oxygen percentage in the lungs. But we are met by the plain facts that have been mentioned.

We believe that the difficulty of the subject can be easily cleared up. When experimenters determine the quantity of oxygen absorbed by blood from various mixtures of that gas with nitrogen and carbon dioxide, they allow time for reaching an equilibrium. It is plain that when a person is at rest there is time for the saturation of the corpuscles traversing the pulmonary capillaries, even though the transit occupies but one or two seconds. It may be quite otherwise when the circulation is greatly accelerated. The time of the exposure to the air may be reduced to one-half or one-third what it was before. The blood may then fail of saturation because it does not remain long enough in contact with the air. Moreover, we can see how a vicious cycle may be established, for if the blood is not fully arterialized at a time when the muscles make maximal demands upon it, then the circulation must speed up to

make good in quantity what it is losing in quality. More acceleration and less complete arterialization may continue to develop, and the heart may be forced ever to greater labor with an ever depreciating blood to sustain it.

If this conception is correct, we can understand why the inhaling of oxygen helps the athlete. The proportion of oxygen in the alveolar air is usually about 14 per cent. Breathing the pure gas may temporarily increase it three or four fold. This enriched air transfers oxygen to the passing corpuscles in a shorter time than was previously required. No gain is realized from this quickened transfer until the speed of the blood-flow exceeds a certain critical rate. This is the rate which just permits the corpuscles to become saturated when normal air is being breathed. Force the circulation a little farther, and the man with the enriched alveolar air enjoys a clear advantage. His corpuscles may still become fully charged, thanks to the rapid diffusion of the gas under extra pressure. In the subject not so protected there sets in the vicious cycle already noted. His very panting and his excessive heart-action add to his muscular metabolism, and his handicap becomes steadily more grave.

Incidentally we may point to a new reason for seeking a good chest development. It is fair to assume that the number of the pulmonary capillaries and their total surface area will be greater in the subject with the broad and deep thorax. In the capacious pulmonary system the average linear flow will be less than in the contracted one. Therefore the corpuscles will remain longer in diffusion relations with the air in the better developed person, and the circulation in such a wide vascular bed can be relatively more accelerated without danger of shortening the exposure too greatly.

MUNICIPAL SANITATION.

By CHARLES V. CHAPIN, M. D.
Superintendent of Health, Providence, R. I.

GARBAGE TO BE WRAPPED IN PAPER. The last report of the Department of Public Health of Winnipeg refers to the great success attending the use of metallic garbage receptacles in that city. This appears surprising, in view of the fact that in many New England cities much trouble is experienced from the freezing of the garbage to the receptacle, which necessitates the use of a pick, and speedily results in the destruction of the can, or even of cast-iron receptacles. Hence in Providence it has been customary for a number of years, on the advent of freezing weather, to notify house owners to replace their metal garbage cans by wooden ones. A letter from Dr. Douglas, the Medical Health Officer of Winnipeg, explains how metal receptacles can be used in the exceedingly cold winter weather of that city. He states that they have a regulation that the garbage must be drained so as to be free from water, and wrapped in paper before it is thrown into the garbage can. This prevents the freezing to the can in winter, and does much to abate the odor and to deminish the fly nuisance in the summer.

VISITING NURSES FOR CONTAGIOUS DISEASES. Many now believe that more can be accomplished in the way of education by the visiting nurse, than by either the attending physician or the medical inspector. Much

has been accomplished by visiting nurses in the education of consumptives, and in instructing mothers how to care for young infants. For these purposes nurses are very commonly employed by various charitable agencies, and also by departments of public health. They have not hitherto been much employed in cases of scarlet fever and diphtheria, though the education of the family and the patient here is as important as it is in consumption. A scarlet fever nurse and a diphtheria nurse have recently been employed by the health department at Cleveland, and the results are reported as most gratifying.*

MEDICAL TREATMENT OF SCHOOL CHILDREN. The medical inspection of schools was primarily intended merely to discover physical ailments and defects in the pupils and to advise treatment. It was speedily found that in a large proportion of cases the advice, as frequently happens with good advice, was not followed. Then various other steps were taken, nurses were provided to treat pediculosis, ringworm and scabies, and by visits to the homes, to persuade parents to take their children to private physicians or to hospitals or dispensaries. Again trouble arose, for very many parents are unable or unwilling to pay a private physician, and the dispensaries resented the great influx of patients. Then, here and there, a city would establish a special eye clinic, throat and nose clinic, or skin clinic, for the treatment of cases discovered by its inspectors. The tendency has thus been for the municipality to furnish an increasing amount of free treatment for the school children found by inspection to be in need of it.

It is perhaps not surprising that the medical profession should feel that its legitimate practice is being interfered with, though it is very evident that thus far practicing physicians have made more than they have lost, for some

*Report of the Department of Public Health and Sanitation, 1908, p. 5.

of the cases do go to them, while but for the inspection it is improbable that they would have gone to any one for treatment. In Providence the local medical society has recently appointed a committee to inquire into the alleged abuses in connection with the free treatment of school children, and in England several important bodies have considered this subject.

A sub-committee of the Education Committee of the London County Council recently made a report* after a very careful consideration of the matter in conjunction with representatives of the British Medical Association. It was clearly set forth that free medical service must be furnished, and two alternatives were considered. First, that existing hospitals and dispensaries should be subsidized by the County; or, second, that the City Council should establish school clinics at which treatment should be furnished by its own medical officers. The latter course was recommended, but was not adopted by the County Council, which has arranged to make payments to existing hospitals for the treatment of school children, a manifestly unfair proceeding, as the hospital staff who do the work receive no compensation.

The Medico-Political Committee of the British Medical Association† also recognizes the necessity for an increase in free treatment, and for large towns advises the establishment of regular school clinics, but for smaller places advises the employment of private physicians who may receive the patients at their own offices. The committee rightly demands adequate compensation for the physicians for this service, and strongly deprecates the throwing of this work upon the unpaid staff of existing hospitals.

It is the opinion of the writer that a wide extension of free medical service must take place as the result of school

*Public Health, February, 1909, p. 147.

†Br. Med. Jour. Supplement, May 15, 1909, p. 247, and May 22, 1909, p. 271.

inspection, and that the physicians employed must be adequately paid for their services.

THE REGISTRATION OF INFANTILE DIARRHEA. The sanitary authority at Huddersfield, England, has made great efforts to check this disease, and for the purpose of facilitating the work of prevention has, since July 1st, 1908, required the registration of all cases of diarrhea occurring in children under five years of age. The number reported during the first six months of registration was 349, and the medical officer of health apparently considers the registration quite complete. There were 48 deaths during the same period, which gives a case fatality of 13.8 per cent. The population of Huddersfield is, according to official calculation, 94,777 (Report of the Medical Officer of Health of Huddersfield, 1908, page 32). As there are few data bearing on the prevalence or fatality of the group of diseases included in the term infantile diarrhea, the above facts are of considerable interest.

VITAL STATISTICS.

By MARSHALL LANGTON PRICE, M. D.
Secretary State Board of Health, Baltimore, Md.

POPULATION OF CHINA. Some interesting correspondence has recently been made public, between Professor W. F. Willcox and W. W. Rockhill, United States Minister to China, relative to the population of China.* Mr. Rockhill's views are quite interesting. He says among other things: "According to my views, whatever the population was in 1842, it has not probably increased to any perceptible extent since then. I have shown that the estimates made by the Chinese, whenever Western observers have been able to look into them, should be reduced by half in many cases and in others by perhaps a third." Mr Rockhill gives a Chinese estimate of the population of China of 438,214,000, which he characterizes as the "wildest of all estimates." The reliability of the Chinese figures may be judged by the estimate of the population of Scechuan, which is given by the Chinese as 79,500,000, while the estimate of Sir A. Hosie, made in 1904, was only 45,000,000. Mr. Rockhill gives an official Chinese census of Pekin. This takes account only of the number of families. The total number of families in the inner and outer cities is given as 126,008. Allowing to each family five and five-tenths persons, the population of Pekin reaches the modest figure of 693,044. It appears likely from Mr. Rockhill's comments that all the past estimates of Chinese population have been greatly over the true figures.

* Jour. Am. Statistical Assn., Vol XI., Dec., 1908.

OCCUPATION, MORTALITY IN SHEFFIELD. F. S. Crum has recently reviewed the report of the Medical Officer of Health of Sheffield, Eng.* The report is of special interest on account of Sheffield being the centre for the manufacture of tools and cutlery. The individual trades campared are grinders, cutlers, toolmakers, and file cutters. It appears that in all these trades, notwithstanding the excellent regulations of the under Secretary of State governing dangerous occupations, that the mortality from the respiratory diseases continues to be excessive. In some of the occupations the proportionate mortality in certain decades exceeds 70%.

THE SALE OF COFFINS VS. HARD TIMES AND A LOW DEATH RATE. It would appear that coffins are a commodity that would not fluctuate with good and bad times, being, so to speak, in the nature of a necessity; but it appears from the statement of a representative of a large casket company that coffins also share in general financial depression. The statements of this individual are very interesting, even if fallacious. He explains the depression in the coffin business as follows: "The average person, when times are good and his pocket full of money, remains downtown at his club or at his beer garden (according to his tastes and income) and spends his evening and incidentally his money with his friends to the accompanyment of lobster Newburg and highballs, champagne, or other liquids. Result: An obituary notice in the daily paper. On the other hand, during hard times, when the pockets are not so well supplied and the quotations on champagne and lobster Newburg remain high, the individual remains at home, to the betterment of his finances and health, all of which would indicate that the straight and narrow path leads away from the casket maker and the village churchyard."

*Jour. Am. Statistical Assn., Vol. XI., Dec., 1908.

There is doubtless some sound reasoning in this homely philosophy; at any rate, there are other more important reasons why the death-rate should be low during and immediately following a period of hard times. As is well known, the birth-rate is apt to be low during the period of depression, and consequently the death-rate is likewise depressed. A great many industrial establishments are closed, consequently the number of deaths from accidental violence is decreased. In the clerical class the rush, worry, and long hours, incident to times of prosperity, are succeeded by a period of comparative leisure and light work, all of which causes tend to diminish the death rate.

THE ACCESSORY CAUSES OF ILLEGAL INTERMENTS. The analysis of one hundred and seventy illegal interments, which occured in Maryland from January to August, 1908, gives some very interesting results. These interments were divided by months as follows: In Jan., 18; Feb., 27; March, 36; April, 24; May, 14; June, 15; July, 22; Aug., 14. The bulk of these interments occurred in the remote rural districts. Only two illegal interments occurred in the larger towns. The interments in the first quarter (including the winter months) number 105, as against 65 in the second quarter. The predominating causes in the first quarter were cold weather and bad roads. Thus, bebeginning with such interments in January, the number increases to 27 in February, which is generally the coldest month, and reaches its maximum in March, 36, when the roads are in their worst condition following the spring rains and thaws. The number again declines during April, reaching the minimum in June. There is a sudden increase in July, doubtless due to the necessity for early interment on account of hot weather.

THE PASSING OF THE CENTENARIAN. Dr. Woods Hutchinson, under the title of "The Vanishing

Centenarian; New Light on a Very Old Subject," has thrown a search-light upon the halos of antiquity surmounting the heads of many village patriarchs, with considerable damage to the said halos. To village gossip and popular credulity Dr. Hutchinson opposes the following cold, hard facts. First, that all the reputed persons of extreme age were extremely illiterate and possessed no authentic records. Second, as Dr. Hutchinson says, "All authorities are agreed that of the one class of human beings whose births and deaths are sure of accurate and indisputable record,—the royal families of Europe,—not one has ever reached one hundred years. The same is true of three hundred Popes: indeed, of these only five passed eighty years, and in twelve hundred years only six kings have reached fourscore years. No English insurance company in one hundred and thirty-five years has paid a death-claim to any beneficiary over ninety-six years."

Such evidence as this alone should make us skeptical of accepting the numerous recorded deaths at ages exceeding one hundred years; but not satisfied with this, Dr. Hutchinson has hunted the centenarian in his lair The results of these investigations is the overthrow of many village idols. Dr. Hutchinson even casts aspersions on the time-hallowed Thomas Parr. He is also more than skeptical about the number of persons of phenomenal ages, whom Metchinkoff believed he had found among the ignorant peasantry in the remote mountain villages of the Caucasus, and upon whom the celebrated "sour milk" specific for old age is founded.

THE MAKING OF A CENTENARIAN. In order to understand the making of a centenarian, we must consider somewhat, the psychology of the mind of the aged. We will consider by preference the "seven ages of woman" rather than the "seven ages of man," because, while a man's estimate of his age may be as unreliable as that of a woman in the latter end of his life, a woman's age is as consistently

unreliable throughout her life as the wind, the weather, or any other manifestation of nature. We will assume that a woman has successfully reached her twentieth year. In five more years she is twenty-five; in five more years she is still twenty-five; in ten more years she is thirty-two. At the age of fifty her official age and birth certificate begin to correspond fairly closely. At sixty-five she begins to take a mild pride in her age, and this becomes very much intensified from seventy up. Her interest in contemporaneous affairs is slight, but she takes a great pride in being consulted about such matters as "who built the first house in Smith's Hollow," or "the time the flood washed the railroad bridge away." Here enters the special peculiarity of the aged mind. As is well known the loss of memory in the old, is largely due to an anterograde amnesia and fixation deficiency. That is, while the loss of memory from mental disease is apt to be retrograde, the memory of past events may be clearly retained, but the relation to present events, upon which the sense of time largely depends, is lost. For this reason the same event may at one time have appeared to have occurred only a few weeks ago, and at another to have receded into the dim past. A secondary consequence is that events which the individual has heard discussed in her childhood, and which happened in the life of her parents or grandparents, may appear to her to have been actual occurrences in her own life.

STATISTICS OF AGE AMONG THE ILLITERATE. Not only are the recorded ages of the illiterate notoriously inaccurate, but the general returns of ages, even as low as sixty years and upwards, are so inaccurate as to possess little value. This may be easily observed by examining any table of presumptive expectations and duration of life, arranged by quinquennial periods. This table is founded upon average age at death of those dying in any quinquennial period. It will be found that while there is a constant,

uniform decline after the fifth year, extending to the sixtieth year, there are almost always eccentric fluctuations after the age of sixty.

COWS CAUSE CONSUMPTION,—COWS TUBERCULOUS, COWS STATISTICAL, COWS RAMPANT AND OTHER COWS. Mr. Nathan Straus, of New York, and the Cow appeared simultaneously in the limelight of publicity at the recent meeting of the National Association for the Study and Prevention of Tuberculosis in Washington. Mr. Straus stated that the recent vigorous campaign against tuberculosis had failed to check the great white plague, and that the official statistics of the New York Health Department showed an increase of 33% in two years in cases of tuberculosis, "in the city that Dr. Koch described as leading the whole world in the fight against the disease." The reason for this serious state of affairs, Mr. Straus declares, is THE COW.

Mr. Straus's weapon (to meet the cow on her own ground, so to speak), is universal pasteurization, and tuberculin testing. Mr. Straus's alarm is due to two fallacious arguments. First, accepting the actual increase in the reported number of deaths as an increase in the death *rate*. ignoring the rapidly increasing population of New York. Second, accepting the increase of reported cases as an increase in the actual number of infections.

On the latter ground we might report an increase of two hundred per cent. in Maryland in the past four years. If either increase were correct and constant it would only take about six years to depopulate Maryland and about eighteen years to depopulate New York.

The New York City Department of Health furnishes the following interesting statistics in reference to Mr. Straus's statements:

"In a statement appearing in the newspapers, Mr. Nathan Straus is quoted as having said that there had been consid-

erable increase in tuberculosis in New York City in the past two years, and that the present measures had proven utterly inadequate to deal with the situation. This increase he is reported to have referred to infection through the milk of tuberculous cows.

"A careful examination of the records for the last few years shows that this interpretation of the facts is entirely unwarranted. There has been an increase in the number of cases of tuberculosis reported to the Department of Health, but there has been a steady decrease in the tuberculous death rate, the rate for 1908 being the lowest in the history of the city, and more than forty per cent. lower than when the Department of Health first undertook this work more than twenty years ago.

"It is true that the number of new cases reported has increased materially during the last two years, but this increase in the number of cases is simply the result of the earlier and more complete reporting of cases, and has been continuous since 1894.

"The unusual increase in 1908, we are warranted in believing, was one of the beneficial effects on the publicity attending the meeting of the International Congress on Tuberculosis in Washington and the holding of the Tuberculosis Exhibit in New York City. The correctness of this assumption is further indicated in the last two quarters of the year, when nearly three thousand more cases were reported than for the corresponding priod in 1907.

"Below are given the death-rates from tuberculosis per one thousand in population for a series of years, also the new cases of tuberculosis reported each year in the Greater City since 1900:

TABLE SHOWING NEW CASES OF TUBERCULOSIS REPORTED IN EACH QUARTER OF 1907-1908

	1904	1905	1906	1907	1908	1909
1st Quarter	4705	5137	5266	5330	5408	6002

2nd	Quarter	4960	5255	5126	5147	5798
3rd	Quarter	4704	5561	5147	4702	5945
4th	Quarter	4354	4878	4546	4546	6294

Year	Tuberculosis death rate per 1000 population	New cases of Tuberculosis reported
1900	2.79	11,977
1901	2.64	13,397
1902	2.42	12,346
1903	2.46	15,214
1904	2 50	18,723
1905	2.40	20,831
1906	2.45	20,085
1907	2.39	19,725
1908	2.29	23,325

While it is undoubtedly desirable to pasteurize the milk of tuberculous cows and also milks of unknown origin, it is not likely that milk plays a very serious part in the causation of tuberculosis. In Germany, where milk is practically always taken boiled, the death-rate from tuberculosis is probably somewhat higher than in the United States. In China, where the inhabitants take milk about as frequently as we would eat edible bird's-nests, consumption is very prevalent.

PUBLIC HEALTH LEGISLATION, NEWS AND NOTES

By F. H. SLACK, M. D.
Director, Boston Board of Health Laboratory

PUBLIC HEALTH ACTIVITIES IN THE PHILLIPINES. The annual report of Dr. Victor G. Heiser, Director of Health for the Phillipine Islands for the year ending June 30th, 1908, has just been issued and is a most instructive and interesting document.

Beginning with a brief résumé of sanitary work since the American occupation, from which one gathers that not the least of the benefits thereby accruing to the natives are those of practical, and intelligently administered health regulations, the report goes on to describe in detail the various diseases met with and the methods of combating them. While the commonplace demands on the force and time of the employees of the Bureau of Health are quite sufficient to keep every one busy, several scientific investigations have been made in public health matters. The diseases of uncinariasis, amoebic dysentery, cholera and trachoma have been the subjects of special attention, and the many treatments for leprosy which are constantly recommended have nearly all been given a faithful trial, the X-Ray treatment having given most hope.

The work on segregation of lepers of the Islands although not complete already shows results in the greatly decreased incidence of this disease and is indicative of its final complete extermination.

The population of the Island, stationary for years, and still subject to an enormous infantile death rate, shows a gratifying increase as a result of the work done.

Manila with its pure water supply, sanitary sewage disposal, hospitals, dispensaries, medical inspection of schools and enforcement of pure food and milk laws is an example of what modern sanitary science can achieve in rendering the tropics habitable and healthy. In view of her excellent hospital facilities, her two medical schools, and of the presence of the large staff of the Bureau of Science engaged in research work, she seems destined to become the medical center of the Orient.

A LAW PROVIDING FOR THE INCORPORATION OF MEDICAL MILK COMMISSIONS and the certification of milk produced under their supervision has been enacted by the Senate and General Assembly of the State of New Jersey and approved by the Governor, April 21st, 1909.

This law was inspired by the Essex County, New Jersey Medical Milk Commission, the original one of the half hundred or more similar commissions now established in the United States.

These Commissions have in some places operated at a disadvantage in that they had no such legal standing and that anyone who wished could with impunity advertise milk as certified which had not received the careful attention for purity guaranteed by the Medical Milk Commissions.

Such a law as that passed in New Jersey should be on the statute books of every state having a Medical Milk Commission guaranteeing them protection in their good work and safeguarding the public against fraudulent dealers.

MARY MALLON, BETTER KNOWN AS TYPHOID MARY,* has recently endeavored, by counsel, through a writ of habeus corpus to secure her release from North Brother Island, where she has been confined since March, '07, by the New York City Board of Health.

*The Evening Sun, July 16, 1909.

Her counsel asserted that her confinement was illegal, that even though she were so infected with typhoid fever germs that she gave that disease to persons with whom she came in contact, there was no warrant in law for confining her. He said that there was no more reason for imprisoning Mary than there was in seizing and depriving the thousands of persons afflicted with tuberculosis of their liberty and that if she was legally confined the Board of Health could take many thousands of typhoid carriers from their homes and families and deprive them of their liberty.

The Corporation Counsel opposed the release of the woman and submitted to the Court a return setting out the alleged facts connected with the case.

Dr. Westmoreland, resident physician in the Riverside Hospital on North Brother Island, set forth in an affidavit that the hospital was designated for the care of persons suffering from contagious and infectious diseases. He said that Mary Mallon was received at the hospital in March, '07, having been sent there by the Health Department. The record recited that Dr. George A. Soper made an investigation for the Health Department of the patient and her history. Dr. Soper reported that he found that she was infected with typhoid, that in eight years she had been employed in eight families; that in seven of them typhoid followed her appearance and that twenty-six cases were traced to her. Dr. Westmoreland certified that she was infected with typhoid bacilli.

In his decision suggesting that the unfortunate woman, if she desired, could have a referee appointed to hear evidence and to report whether it was true, as she asserted, that she was free from typhoid germs and should be released, the Court says:

"A careful examination of the return and traverse and the certificates submitted satisfy me that the risk of discharging the inmate of the Riverside Hospital is too great

to be assumed by the Court. The injury which may be done to innocent persons if the facts stated in the return be true are incalculable.

"While the Court deeply sympathizes with this unfortunate woman, it must protect the community against a recurrence of spreading the disease. Every opportunity should, however, be afforded to this unfortunate woman to establish, if she can, that she has been fully cured. And she may, after further examination of her, and additional proof of the truth of the traverse, renew the application; or, if the petitioner prefers, the matter may be sent to a referee under section 1015 of the code to take testimony and report to the Court with his opinion. This will give her an opportunity to cross examine the witnesses called against her and to offer her own medical experts to sustain her claim."

THE DEMAND FOR PROPERLY TRAINED MEN IN PUBLIC HEALTH WORK. There seems to be an increasing demand for trained men in Public Health work whether in executive, laboratory or sanitary lines. It is a pleasure to give a word of welcome to those newcomers who, having had special training, are now actively engaged in their chosen profession, and who will soon be giving us the benefits of their experience. Among others we may mention, Robert N. Hoyt, S. B., Mass. Inst. of Tech. now with Dr. George A. Soper of the Metropolitan Sewerage Commission, New York City, Aubrey Straus, A. B., recently appointed City Bacteriologist of Richmond, Va., W. S. Blanchard, M. D., Tufts Medical School, Boston, appointed Assistant Bacteriologist of the Boston Board of Health Laboratory, and C. K. Blanchard, S. B., of the Mass. Inst. of Tech., appointed to take charge of the bacteriological and sanitary work of the town of Wellesley, Mass.

RESIGNATION OF DR. HERBERT D. PEASE.

The following item of interest to public health workers, appeared in a recent issue of an Albany, (N.Y.) paper:

Dr. Herbert D. Pease, director of the State hygienic laboratory, has sent his resignation to Dr. E. H. Porter, State commissioner of health. Dr. Pease goes to New York city September 1 to become director of the bacteriological work of the Lederle laboratories, the founder and president of which is Dr. Ernst J. Lederle, former health commissioner of New York city, and at present a member of the State water supply commission.

Dr. Pease has been in the service of the State health department since 1901, first as director of the antitoxin laboratory and more recently as the chief of all that department's laboratory work. He has conducted many of the investigations of epidemics of typhoid fever and other infectious diseases and has been a leader in the educational work along public health lines, especially in the development of exhibits, and particularly in the State tuberculosis campaign. He organized and had charge of the tuberculosis exhibition from New York State at the International Congress on Tuberculosis held in Washington last fall. This exhibit was awarded the highest prize, the gold medal for State exhibitions at the congress.

Dr. Pease has been closely associated with the work of the Albany committee for the prevention of tuberculosis and has given a large number of illustrated lectures on tuberculosis and other public health topics, both here and in other parts of the State. He has also held the

chair of lecturer on antitoxine and immunity at the Albany Medical college for the past eight years.

The scope of the work of the Lederle laboratories embraces all phases of sanitary science.

A. J. Slack, assistant chemist in the State Hygienic laboratory, is also leaving to accept an important position in the laboratories of the State Board of health of Ohio, at Columbus.

VETERINARY HYGIENE.

By W. L. BEEBE, D. V. M.
Bacteriologist for the Minnesota State Live Stock Sanitary Board

IMMUNIZATION AGAINST BOVINE TUBERCULOSIS. The several methods that have been introduced by Von Behring, Koch, Lignières, Arloing, Pearson and others, in the last ten years for immunizing cattle against tuberculosis have all been tried with various results. The one that had been used most extensively in this country was that recommended by Von Behring, which consists of two inoculations of a dried attenuated culture of human tubercle bacilli. By this method it has been proved that immunity is conferred upon the host, but it is not lasting, usually subsiding in from one to two years. This seems to be the fault of all the methods yet tried.

Recently Pro. J. F. Heymans* has introduced a new method which he has tried quite extensively in Belgium. He describes the procedure as follows: "We place about 1 mg. of living bacilli to which some powder is added (what quality and quantity of bacilli gives the best results has not yet been ascertained) in a reed sac which is closed, and for safety's sake coated over with colloion and this sac filled with bacilli is inserted under the skin of the animal."

The following results were obtained in the experiments: "That this heightened resistance of vaccinated animals to experimental infection suffices to protect them materially against natural infection is shown by various experimental

* Protective vaccination of cattle against tuberculosis. Am. Vet. Rev. Vol. XXXV. No. 4, pp. 410-415

series carried on in practice. Ten non-reacting cattle, five of which we vaccinated were put into an infected stable."

"When slaughtered five months later, one of the five vaccinated was tuberculous, the other four not; whilst of the five not vaccinated, four were tuberculous and one not. Of eighteen other sound cattle, nine of which were vaccinated, six of the control animals were tuberculous and three healthy; of the nine vaccinated, two were tuberculous, one was doubtful, and six were healthy (post mortem)."

"Of over 4,000 vaccinated healthy cattle (1905-06-07) retuberculinization showed that the majority of them (about 80 per cent.) did not react; i.e., they remained free from tuberculosis if we can depend upon the tuberculin reaction in vaccinated animals. Careful autopsy of these animals alone can decide. Among the hitherto autopsied animals (about 500) there were about 150 sound vaccinated, which had not reacted to retuberculinization; tuberculosis lesions were found in six. If, therefore, the injection of tuberculin be practical about a year after vaccination, its diagnostic value is as great in the vaccinated as in the unvaccinated."

IMMUNIZATION OF HOG AGAINST CHOLERA. Since 1905 when Dorset, Bolton and McBryde announced that hog cholera was not due to *B. cholerae suis* but to an ultra microscopical organism, their results have been verified by many workers, both in this country and in Europe.

One of the most important points which did not indicate that hog cholera was due to *B. cholerae suis*, as formerly supposed, was that the immunity produced by this organism was not lasting while immunity from natural infection would last for several years and in fact in many instances as long as the hog lived.

Later Dorset, McBryde and Niles found that they could hyperimmunize immune hogs by injecting them at intervals

with large quantities of virulent hog cholera blood. The blood from the hyperimmunized hogs has sufficient potency to protect a susceptible hog for three weeks. If 2 c.c. of virulent hog cholera blood is injected into a hog weighing about 50 pounds, simultaneously with 20 c.c. of blood from a hyperimmunized hog, an immunity lasting 3 to 4 months, and probably longer, is produced. This immunization method is now beyond the experimental stage and many state agricultural experiment stations are producing serum and virulent blood and dispensing it to the farmers as a prophylactic against hog cholera. Serum alone does not seem to have very much power as a curative agent unless administered very shortly after symptons are manifested.

If equally good results are obtained in the future as are reported now, this method of immunization will be a great boon to the hog raising industry. It is estimated that the annual loss from this disease amounts to from $10,000,000 to $50,000,000 annually. Probably $50,000,000 is altogether too high and $10,000,000 too low. But even if it does not exceed the lowest estimate it would be a great saving to the farmers if this disease could be prevented. But before this is accomplished the farmer must be taught that hog cholera is an infectious disease and not due to corn feeding and poor hygienic conditions as many of them now believe. Further, it must be emphasized that the serum treatment is a prophylactic agent and of very little therapeutic value. One drawback to this method of immunization is that it is expensive, actually costing about 2 cents per. c.c. for immune serum and 1 cent per c.c. for virulent blood, where it is produced on a large scale by scientific institutions. Although this charge may seem exhorbitant to the farmer it will pay him in the end to have his hogs immunized.

BOOK REVIEWS.

The Planning of Fever Hospitals. By ALBERT C. FREEMAN, M. S. A. *The Sanitary Publishing Co., London,* 1909. 16*pp.*, 140 *Illustrations.* 7*s.* 6*d.*

This little book should be in the hands of all who contemplate the erection of a hospital for the care of infectious diseases. It refers chiefly to English practice though the plan of one of the more modern Parisian isolation wards is included. The chief value of the work to the health officer is that it contains a large number of well selected plans which must certainly offer many useful suggestions to those who are considering the erection of a hospital.

CHARLES V. CHAPIN.

DEATH OF DR. QUITMAN N. KOHNKE.

To the many friends of Dr. Kohnke, long a conspicuous figure in public health work, the following news, copied from the Journal of the American Medical Association for July 10, 1909, will come as a distinct shock.

Quitman N. Kohnke, M. D., Tulane University of Louisiana, New Orleans, 1890; a member of the American Medical Association; for eight years president of the board of health and health officer of New Orleans; once a member of the city council; who figured conspicuously in the yellow-fever epidemic in New Orleans in 1905; died at his summer home in Covington, June 26, from cerebral hemorrhage, aged 51.